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Engineering Library

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS from such persons as may be willing to SUPPLY—

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The conditions of contract may be obtained on application to the Director-General of Stores, India Office, Whitehall, S.W. 1, and Tenders are to be delivered at that office by Two o'clock p.m. on Tuesday, the 11th October, 1921, after which time no Tender will be received.

T. RYAN,
Director-General of Stores.
6227

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City of Cardiff Education Committee.

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(Signed) F. E. THOMPSON,
Secretary.

10th September, 1921.
Education Office,
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RAILWAY COMPANY.

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	s. d.
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Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Chints, Turbans, &c.," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 4th October, 1921.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C. 2.
London, 21st September, 1921. 6230

The National Foremen's Association of the ENGINEERING AND ALLIED TRADES.

(Registered under the Trade Union Act.)

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H. W. REID, 95, Belgrave-road,
General Secretary. Victoria, S.W. 1.
Ex.

The Engineer

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(CIVIL, ELECTRICAL, GAS, MARINE, MECHANICAL AND MOTOR CAR).

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WESTMINSTER TECHNICAL INSTITUTE, Vincent Square, S.W.1. (Civil and Gas).
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Full particulars as to fees, etc., may be obtained on application at the various institutions.

Evening Classes open 19th September, 1921.

JAMES BIRD,
Clerk of the London County Council.
6133

PUBLIC NOTICES

New Zealand Government.

TENDERS are INVITED for the SUPPLY of ELECTRICAL PLANT, as set out hereunder, for the Mangahao Power Scheme, and should be lodged in writing with the SECRETARY, Public Works Tenders Board, Wellington, New Zealand, not later than Noon on Tuesday, 29th November next. Tenders to be endorsed "Mangahao Electric Power Plant."

SECTION 12.—WATER WHEELS, &c.
" 13.—GENERATORS.
" 14.—2-UNIT EXCITERS.
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" 17.—110,000-VOLT INSULATORS.
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6199

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6186 A

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6171 A

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PUBLIC NOTICES

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6208 A

SITUATIONS OPEN (continued)

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The position demands initiative, energy, and an exceptionally high degree of scientific and technical knowledge and a wide practical experience.

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6179 A

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6198 A

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6192 A

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WANTED by Old-established Engineering Firm in India, MECHANICAL DRAUGHTSMAN, age about 25, single.—Reply, stating age, experience, and salary required, Z. W. 598, c/o Deacon's, Leadenhall-street, London. 6222 A

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WANTED by Old-established Engineering Firm in India, JUNIOR WORKS COST ACCOUNTANT, age about 23, single.—Reply, stating age, experience, and salary required, Z. Y. 600, c/o Deacon's, Leadenhall-street, London. 6224 A

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Die Casting.

No. II.*

By A. G. HOPKING.

Melting the Metal.—All the die-cast alloys can be melted in cast iron pots heated by gas, except aluminium-bronze, which is melted in plumbago crucibles in coke-fired furnaces with natural draught. In mixing, as a rough general rule, the high melting point metals are put in to melt first and the others in order of their melting points; but this is not always the case. If a coke furnace is used there should be a solid bed of fuel 8in. thick between the crucible and the fire-bars. When this has been ignited by the wood, shavings and tar below it the crucible is set, the metal put in, but not too full, charcoal sprinkled over to keep in the heat and keep oxygen out, and coke heaped up round the crucible. Charcoal is not used with aluminium alloys; salt or zinc chloride can be employed. In general deoxidisers add to crucible costs, and with careful melting should not be needed. The greatest care must be taken to avoid overheating, for which reason gas or oil furnaces are best for aluminium. A pyrometer should be used if one can be found to stand it. To avoid slow melting and increased oxidisation the draught must be good, and with a battery of furnaces the main flue area must equal the combined area of the flues leading into it.

With aluminium-bronze the copper and iron are melted first, then aluminium is added to form billets of hard close-grained alloy of the proportion 3 : 1 : 1. When casting, copper is melted first, sometimes with a flux, the alloy added, and, lastly, the aluminium just before pouring. Charcoal on the surface prevents oxidisation. The flux sometimes used is 1 lb. of calcium silicide and 2 oz. of antimony to 400 lb. of aluminium-bronze.

When melting Babbitt metal, tallow or resin is used to collect dross and oxide. When melting an aluminium base alloy which includes copper, a hardening alloy is first prepared of the copper and an equal amount of aluminium. This is later melted with the rest of the ingot aluminium.

Casting.—The final act of pouring the metal depends on whether a machine is used or not. If a machine is used it is just a matter of turning a handle or lever which will actuate a plunger or admit air pressure, so forcing the metal into the die. For hand-poured work, or casting in chills, as it is often called, the metal is scooped up in a small hand ladle and poured into the vertical runner of the die until it reaches the top of the riser, so indicating that the die is filled. The casting is set almost at once. The core pins are pulled out and the two die halves taken apart, the casting removed and the die face lubricated for another cast. Oil and blacking, beeswax, vaseline, and French chalk are variously used on the die face for pressure work; a wash of blacking water is sufficient for hand-poured dies, in which also core pins and plugs are cooled to prevent warping. At present aluminium-bronze is not cast in pressure machines.

Die Design.—On leaving the metallurgical aspect of the process one comes to that which is perhaps the most important and most interesting step in the evolution of a good die casting. The die must be made of some substance which will not alter its shape or warp in the very least, which will stand up to the stresses caused by the high temperature of the molten metal, resist the alloying action of those metals and the oxidising action of the air, and be neither too hard to machine nor soft enough to get worn.

Lead, tin, and zinc bases will be satisfied by a cast iron die for hand-poured gravity-fed work or mild steel for pressure work. For hand-poured aluminium cast iron dies will suit; rapid repetition work on a pressure machine requires cast iron dies with mild steel or vanadium steel inserts and core pins. Important parts of the mould are made as separate inserts or plugs. They can thus be easily replaced when burned, and also can be made of special costly steel which is corrosion resisting. Vanadium steel is valuable for this purpose. Another special alloy steel is titanium. These metals are dense and without blow-holes, since the gases which would become occluded are expelled when cast. The less important parts of the die for aluminium pressure work can be of cast iron, although that metal begins to flake and become pitted above 540 deg. Cent. For aluminium-bronze work close-grained chill-cast iron dies with tool steel inserts and chrome-tungsten core pins are used. Two analyses for chill cast iron dies are :—

	Per cent.		Per cent.
G.C.	3.35		2.76
C.C.	.135		.840
Si	2.40		2.02
Mn	.43		.29
S	.10		.07
P	1.30		0.89

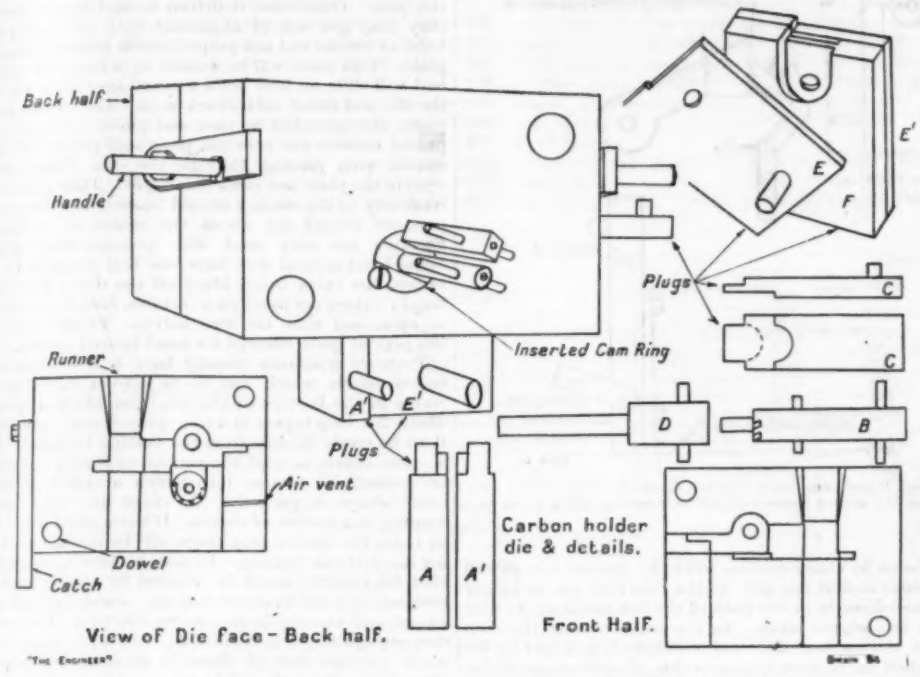


FIG. 1.—This die is used for casting the carbon holder shown in Fig. 2. The die is shown closed with plugs and inserts in place, and both catches fitting over the handles of the front half. Each plug is shown in detail and lettered according to the part it helps to mould. Refer also to Fig. 2.

As an example of a die for pressure machine work we may take as fairly typical the case of a die for four white metal bushes which are cast together. The metal enters the die by a central sprue or runner and reaches the die cavity for each bush by a narrow gate or fin whose thickness is about .02in. Three die blocks and the stripper plate are first planed and their faces ground or smoothed with emery paper on a file in order to ensure a good fit when closed. The plates or blocks are clamped together and four dowel pin-holes bored, the pins themselves being hardened and ground tool steel. These holes are bored in a drilling machine with a taper shank boring bar. Then the four dowels and the two stripper plate guide pins are fitted and holes for cones and bushes rough drilled, being finished on a lathe face-plate, an allowance of .003in. on the diameter and .004in. on the depth being made in the boring of the bush holes. The cores are of tool steel, slotted for an oil groove $^3/_{32}$in. by $\frac{1}{4}$in., and left unhardened. They are a driving fit in the middle block and are also pinned. Next the top die block or cap plate is dowelled and screwed in place. Air vents .005in. deep are run from the flanges of the bushes.

Having closed the dies, the metal is forced up the conical sprue, pushing all air out of the vents, and filling the die until its flow is cut off by the descent of the sprue cutter. The top and centre die blocks withdraw the cores and the casting which has shrunk on to them, but only until the casting is clear of the bottom die, whereupon the tripper plate comes against the head of its guide pins and drags the four bushes clear of the still receding cores.

Many other types of die occur in practice. A plain flat object, like a motor cycle chain case cover, would require two thin blocks of steel of about the same thickness; one would be recessed to mould the outside of the cover, the other would have a raised part to form the inside; half the runner would be cut in each block, and the two would be dowelled together by two $\frac{1}{4}$in. diameter pins. The raised half would be pierced for ejector pins, and the back of each half would be drilled and tapped to take the fixing bolts on the pressure machine die holders, and the ejector box.

When laying out the die from a drawing of the proposed article, several factors must be considered. To begin with: Is the design of the article such that it lends itself readily to die casting? This point, so often overlooked, is one of the greatest importance. Continually die-casting firms are expected to produce good finished articles to designs which, to the experienced eye, are palpably impossible. There should be the closest co-operation between the designer of the casting and the maker of the die, for often the die maker can suggest modifications which will greatly help him without making any difference to the designer of the casting.

Whether it is better to have dies drawn out in full or not is a matter of opinion; in some cases it may be necessary, but often it is better to let an expert die sinker set out the die from a drawing of the article, supervised by the engineer, who is in touch with the customer's requirements and the casting and metal-mixing operations. Drawings for dies add considerably to the cost and time of manufacture of the die. In the case of one foundry turning out about 400 white metal parts per day, a difficulty is experienced in getting good die makers, so that in consequence 20 per cent. of the machines are idle, waiting for dies. Since each die costs at least

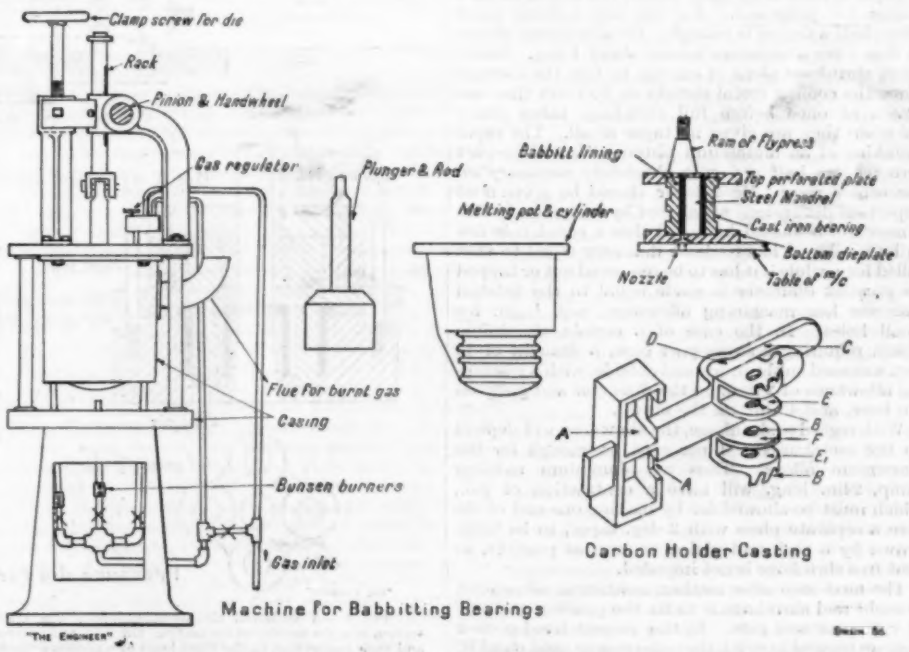


FIG. 2.—Showing an aluminium bronze carbon holder and the parts moulded by means of inserted plugs. Also shown in detail is a motor bearing which is lined with babbitt by means of the small machine illustrated.

* No. I. appeared September 16th.

£50, to ensure a safe profit the order must be for 5000 pieces; 1000 off would be doubtful, and 250 most certainly not worth while; and supposing that a second die had to be made owing to the faulty design of the first, the loss on such a contract might be anything up to £500.

Reverting to the modification of casting design, it is obvious that all holes should be as short as possible in order to reduce the length of core pin exposed to the metal. Furthermore, they should have a slight taper to enable the pins easily to be withdrawn. As many as three sets of core pins may be needed during the life of a die. It should be made sure that shrinkage will not cause fracture of some portion which might easily be strengthened; undercut portions should be eliminated as far as possible; thin flat surfaces should have ribs for stiffness and also to act as feeders, and when lettering is required it should be raised on the casting, since it is easier to sink it in the die face. Sharp corners should be rounded off, since, apart from concentrating stresses under load, they cause rapid chilling and start cooling cracks. The minimum thickness of metal should be $^1/_{32}$in., $^3/_{64}$in. and $^3/_{32}$in. for lead and tin, zinc and aluminium respectively, with least diameter of holes about $^1/_{64}$in., $^1/_{32}$in. and $^3/_{32}$in., the difference being due to different shrinkage and fluidity. The aluminium bronze alloy can easily be run $^1/_{16}$in. thick.

Taper is needed for deep bosses, the degree being a matter for judgment. For the low melting point alloys half a degree is enough; for aluminium alloys, 1½ deg.; for aluminium bronze about 1 deg. Sometimes shrinkage alone is enough to free the casting. Since the cooling metal shrinks on to cores they are drawn at once before full shrinkage takes place, for often they are given no taper at all. The rapid shrinking of an aluminium piston with a three-part core renders half a degree absolutely necessary on the centre piece. More taper should be given if no important dimensions are altered by so doing. In this connection it should be noted that a cored hole not to be machined has its least diameter equal to that called for; while if it has to be reamered out or tapped its greatest diameter is made equal to the finished diameter less machining allowance, say, $^1/_{32}$in. for small holes. In the case of a certain aluminium piston requiring a seven-part core, a draught of 1½ deg. was used on the inside and outside, with a machining allowance of 2 mm. on the diameter and gudgeon pin bore, and 1 mm. on the crown.

With regard to shrinkage, the allowance will depend on the metal used; 1 per cent. is enough for the aluminium alloys. Thus an aluminium radiator sump, 24in. long, will have a contraction of ¼in., which must be allowed for by making one end of the core a separate piece with 2 deg. taper, to be withdrawn by a rack and pinion as soon as possible, so that free shrinkage is not impeded.

The next step after settling machining allowance, draught and shrinkage is to fix the position and size of the sprue and gate. In this respect hand-poured dies are treated in much the same way as sand moulds, the runner being taken from the top and entering at the side near the bottom by a narrow gate, both runner and gate being cut to a size which past experience has shown suitable, but which often has to be either enlarged or partially filled up after trial. A riser will be used to give an indication of the die being full, also as an outlet for air and dross, and an additional reservoir from which the cooling metal can draw. If possible, the metal should have a continuous flow through the mould from runner to riser, or the imprisoned air must be allowed to escape down small vent channels cut along the joint between the two halves. These vents need be no deeper than $^1/_{64}$in., and need not necessarily run to the outside of the die, sometimes being taken to a cavity milled in one block. A longer runner and greater head of metal is required if the metal has to be forced upwards, and it should be remembered that a core pin may so interrupt and cool the flowing metal that it will be too stiff to run into any narrow cavities sheltered by the core. To quote an instance, in a butterfly carbon holder the teeth in a direct line with the core for the spring axis were badly formed or even absent in every casting until the runner was placed nearer and at one side, so that the core pin no longer came directly in the path of the hot metal on its way to the trigger teeth. In the same casting the core for the carbon slot was untapered, and had to be pulled out as soon as practicable, the shrinkage of the aluminium bronze employed being about $^1/_{64}$in. The cores did not last as long as the die, being eaten away by the molten metal, which in time wore away and crumbled the die. Such worn parts should be then milled out, and inserts made and screwed in from the back by countersunk screws into tapped holes, the insert cavity having a clearance so long as the joint does not come in contact with the casting. After being planed up on back and sides and parted off, these die blocks are scraped on the faces instead of being ground, then drilled for dowel pins and the die cavity marked out and milled. The teeth on the casting are formed by two plugs, one a tight fit in the other after its end has been serrated or grooved to the shape of the teeth, which are inclined at 50 deg. and $^1/_{16}$in. thick, the thickness of the outer plug or tube being made the same. The inner plug is pinned in the tube, which is re-turned to make it true once more. A guide pin projecting from this plug slides in a 50 deg. groove cut in a guide bush inserted in the back of the die and screwed in position. Thus the core plug can be twisted clear of the newly cast teeth and pulled out, leaving the casting free for removal. Sometimes internal core pieces are removed with the casting and extracted later; thus the core for internal threads will have to be screwed out of the casting while hot. Internal threads below ¾in. diameter are inadvisable. In any case a Whitworth shape is best for its rounded corners, but internal threads in aluminium should not be cast. If there are many core pins, it is advisable to make a floating fit in a holder plate by giving the core pin holes in the plate .002in. diameter greater than the pins. Otherwise, if driven in and headed over they may get out of alignment with the core pin holes in the die and not perpendicular to the core pin plate. This plate will be worked by a toggle or rack, and will slide on four bolts screwed into the back of the die and fitted with check nuts. The ejector pin plate, also actuated by rack and pinion or toggle, is placed outside the core pin plate and guided by its ejector pins passing through the die. These are rigid in the plate and not a floating fit. Their position relatively to the casting should be such that their net pressure should act about the centre of gravity. Ejectors are only used with pressure-filled dies. Some hand-poured dies have one half clamped to a bench, the other being lifted off the dowel pins by hand; others are fitted on a cast iron base with levers to open and close the two halves. Female labour has proved quite efficient for hand-poured casting.

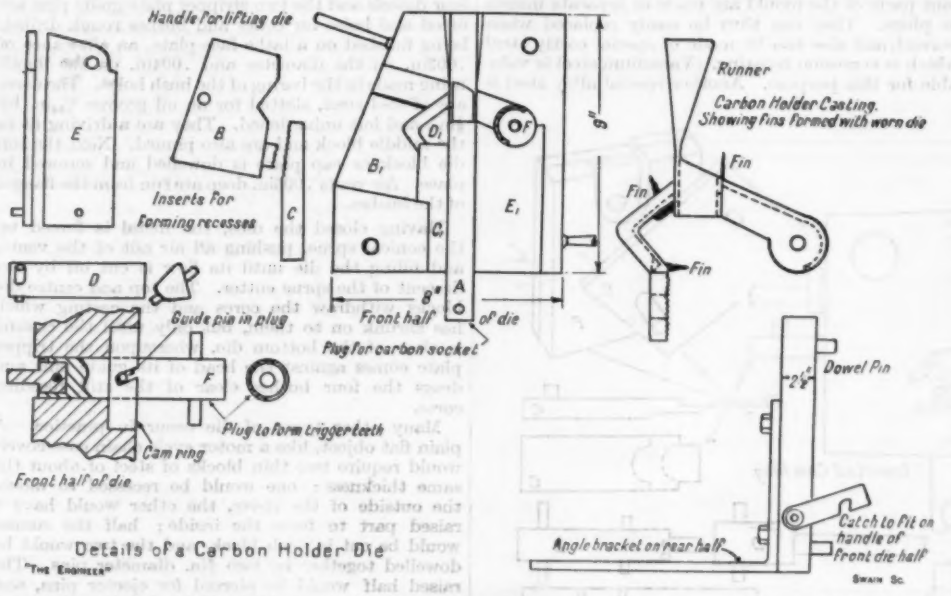


Fig. 3.—Another carbon holder casting and its die. The plug F and cam guide ring are shown in detail. Teeth are formed on one side of the casting only. The plugs are lettered and the dashed letters indicate their corresponding positions in the die.

Die Casting Machines.—Innumerable machines have been invented for speeding up the die-casting process by filling the dies under pressure. These range from small plunger machines operated by hand to most elaborate automatic casting machines which have been brought to a high pitch of efficiency for specialised work in Germany and America. A short description of two typical examples will suffice. The first is a simple plunger machine and very suitable for the white metals, excluding aluminium, its chief use being the lining of cast iron bearings with Babbitt metal. A cast iron pot containing the molten metal is externally heated by three burners of the Bunsen

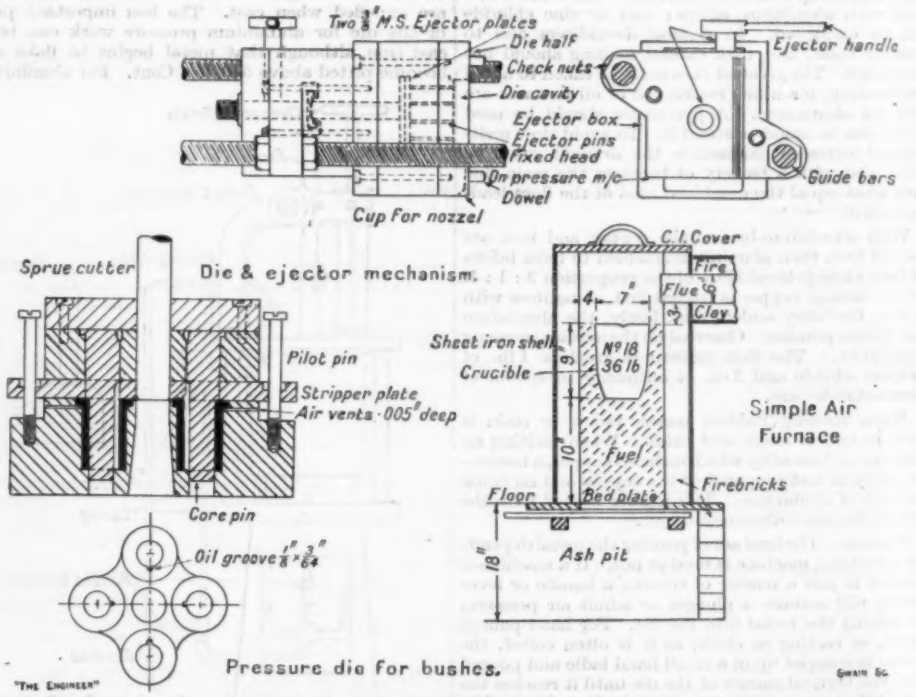
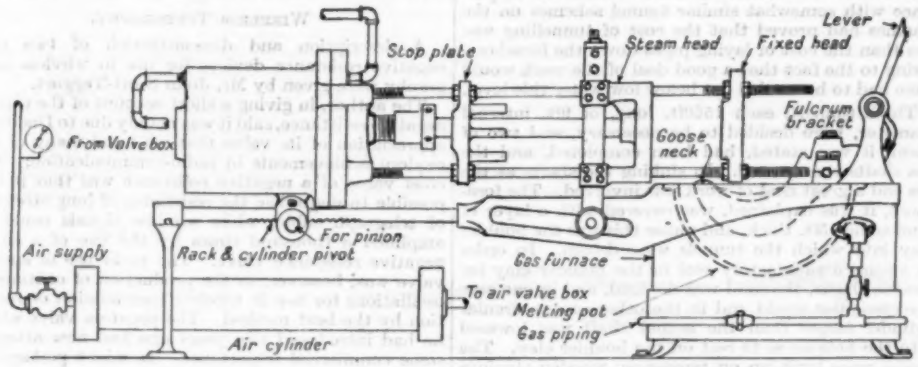


Fig. 4.—A sectional elevation is given of the type of furnace used for melting the metal for die castings, and also a section of a die employed for casting the four white metal bushes shown. Above are two views of half a die, the ejector box, and their connection to the fixed head of a pressure machine, similar to that in Fig. 5 in principle, but having two guide bars only and a fixed head containing rack and pinion for ejection.

type, all being enclosed in an iron frame standing on legs. A plunger works in a cylinder beneath the pot, and on descending forces the metal up a passage ending in a hemispherical nozzle projecting from the horizontal table of the machine, upon which the die is clamped by a fly press. The top of the plunger is cut in the form of a rack worked from a hand wheel and pinion. The method of lining bearings is as follows. Small ingots of Babbitt are placed in the pot to melt, some tallow being added to gather all dirt and oxide on the surface. The bearing to be lined, which in this case constitutes the die, is placed with a core inside and steel plates on top and bottom beneath the ram of the fly press and the table. The core is of ground and polished steel, the actual size of the journal for which the bearing is being made. The top plate is vented with eight small holes; the bottom one has an orifice $\frac{1}{4}$in. in diameter and a cup-shaped recess which fits over the nozzle.

On pulling round the hand wheel, metal is forced into the bearing and appears through the apertures in the top plate. The lining is set almost at once and on unclamping the die the core is knocked out and cooled in water.

As stated above, owing to its rapid surface oxidisation and effects on iron at high temperatures, aluminium is not suited to plunger machines. These two difficulties are best overcome by using air pressure to force in the metal and by the aid of a goose neck, in which a small area only of the molten metal is in



One man operated presure die casting machine.

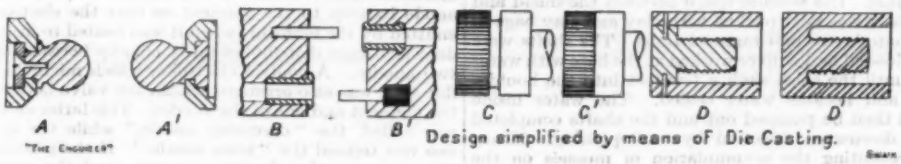


FIG. 5.—A rough sketch of a large pressure machine, the die halves being bolted to the fixed and steam heads, which are closed by admitting steam to the cylinder from a valve chest—not shown. Below are some examples of design details, the pieces as more economically die cast being shown by the dashed letters.

contact with the air, the metal used entering and leaving the goose neck by a nozzle at the end. A steam cylinder at one end of the machine is pivoted underneath to the bed-plate. Two guide bars screwed into its front cover form slides for the crosshead or steam head, which holds one half of the die. The other half is bolted to a plate fixed by check nuts to the screwed ends of the guide bars. This is the fixed head. Two vertical guides from the sliding crosshead work in links with a cam action, so that on admitting steam behind the piston the sliding head moves along the guide bars towards the fixed head, so closing the two halves of the die, but at the same time the dies, their holders, and guide bars are all rotated downwards about the sub-cylinder pivot until the bottom of the closed dies has lowered on to the goose neck nozzle. Metal has been previously admitted to the goose neck by dipping its nozzle below the surface, using a lever at the end of the machine for the purpose. As soon as the nozzle is in the die recess an air throttle lever can be pulled, admitting air at 60 lb. pressure to the back of the goose neck and forcing the metal up into the die. Admission of steam to the front of the piston now opens the die halves and replaces the frame in its previous position clear of the pot of metal. One turn of a crank actuates the ejector plate through a rack and pinion, the casting falls out, the ejector pins are withdrawn by returning the crank, and an air blast is directed on to the die face for the purpose of cleaning and cooling it. If necessary, the goose neck is re-filled and the dies closed ready for the next cast.

This machine is heavy, and takes up a good deal of space, and also needs a supply of gas, steam, and compressed air; but when working at full pressure its output is remarkable, and only one man is required to operate it.

Finally, the castings should be inspected and checked for quality by discovering their weight or specific gravity, which would indicate internal blow-holes if either were below normal.

In conclusion, the future welfare and prosperity of this country would seem to depend on the solution of two vital problems. When the present labour unrest gives way to some acceptable system providing a stable basis for economic progression, then, and then only, will the time be ripe to face the problem of production. Mass production, standardisation, large output—these are the means by which Britain must regain her economic position lost during the war, and this little process is just one of many which will help her to that end.

The British Association.

No. III.*

SECTION G.—ENGINEERING.

UTILISATION OF WATER POWER.

IN addition to the address of the President, which was devoted to a consideration of water power problems, several of the papers presented to the Section dealt with various aspects of water-power schemes.

The general subject of the utilisation of tidal power, with special reference to the Severn estuary, was discussed in a paper presented by Professor F. C. Lea.

Doubts were expressed by the author whether the suggestion to use the available power in the Severn was a sound one. It was, he thought, open to question whether the power could be produced at a rate that would compete with that produced in some stations that at present existed or that might possibly be constructed in the future. The question could only be answered after a full inquiry, not only into the probable cost of the engineering works involved in utilising the tides, but also into the possible market for the energy within a reasonable distance of the area within which it was produced. It was admitted that other conditions being satisfactory, the great range of tide in the Severn marked it out as being particularly suitable for power production. In the neighbourhood of the junction of the Severn and the Wye, the rise of the spring tides was at times about 50ft., but, on the other hand, the neap tides were as low as 16ft. There were two minimum values of the neap tides, however, and two maximum values of the spring tides, and the maximum ranges were by no means equal. From certain points of view, said Professor Lea, the problem would be made easier if the demands made upon the estuary were not greater than could be supplied by the neap tides. Here, again, however, another serious difficulty immediately arose. The times of high and low tides were continuously changing from day to day. If a number of industries could be established in the immediate neighbourhood, the hours of working of which could be adapted to the tides, the problem again would be very much simplified, but that was an ideal condition. A further point was that if power equal to that available at the neap tides only was to be taken from the estuary, the cost of the barrage in proportion to the amount of power available would be very high indeed. On the other hand, if power greater than that available at the neap tides was to be utilised, or if the power equal to that of the neap tides was to be available at hours suited to the needs of industries rather than at the times suited to the tides, large storage capacity was essential, of either an electrical or hydraulic character. Whether large storage of electrical power could be economically effected was probably open to question unless new forms of large capacity storage batteries could be developed. The storing of power hydraulically meant clearly a large expenditure on civil engineering works and also on hydraulic plant. Turbines would be required in the barrage to generate electrical power at times controlled by the tides. This would have to be used partly to supply the demand, and partly to drive pumps for raising the water to a suitable storage level. There would, moreover, be a great loss of efficiency associated with the use of the high-level reservoir to supply hydraulic power when required. In any case, it was doubtful if the mean power available at the distributing station would be more than 50 to 60 per cent. of the tidal water horse-power. Various suggestions had been put forward in connection with the type of plant to be installed, but Professor Lea indicated that reversible pumps connected to rotors which could either be direct-current motors or alternating-current generators, would lead to the most economical solution as far as hydraulic plant was concerned, but the final answer to the question as to whether it was worth while installing reversible turbines would have to be made when it was shown that such a turbine could be economical as a turbine and as a pump, and when the capacity of the station had been fixed. If suitable storage could be provided, Professor Lea estimated that there should be easily available for a ten-hour working day, assuming for the whole system an average of 55 per cent. efficiency, a mean output of not less than 500,000 horse-power for a ten-hour working day. The number of turbines required, if working on a half-tide system, would be from 600 to 900, depending upon the horse-power of the units. If, however, the plant were worked on the system of a range from 6.5ft. head to 6.5ft. head and a fall of half a tide, the number of turbines would be only from 400 to 600, depending upon the size of the turbine determined upon. At neap tides, the total energy available would be 372,000 horse-power for nine hours per day, or 481,600 horse-power could be produced for six hours per day on the half-tide system, but the number of turbines required would be greater. From this point of view, therefore, it would be better to work on the variable head system. If the demand at any time increased, there would be turbines available to meet the peak load. The type of turbine to be used at the barrage must be the modified Francis, known as the mixed flow turbine. The whole scheme would, however, have to be thoroughly investigated before a final policy could be framed.

Long-distance transmission of electrical energy generated by means of tidal power was discussed on a communication from Dr. T. F. Wall. He dealt in some detail with the Severn scheme. The proposals put forward involved, he pointed out, the use of special direct-current generators, driven by water turbines, the generators being so designed that each machine would develop about 1300 kilowatts at a constant pressure of 525 volts, and at speeds varying from 300 to 500 revolutions per minute. The direct current so generated would then be supplied to rotary converters giving 320 volts alternating current, and this would be raised to pressures of 60,000 and 100,000 volts for transmission to the Midlands and the London district. Owing to the varying speed of the turbines, the use of alternating-current generators driven by the turbines was in the ordinary way impracticable, as the generated E.M.F. would be of varying frequency, and, moreover, unless elaborate automatic arrangements were made the generated E.M.F. would also vary in magnitude more or less in proportion to the speed variation. Such large variations of frequency and E.M.F. would be impracticable for feeding a distribution system, for the obvious reasons that motors, such as induction motors or synchronous motors, would have similar speed variations independently of the requirements of the consumer, and lighting and heating appliances could not be operated from a system of which the pressure was widely varying.

It was clear therefore that the proposal to generate 500,000 horse-power by means of 1300-kilowatt direct-current units, and then to convert to alternating current, would involve a very large number of machines, and the capital outlay might be so large as to imperil the carrying out of the scheme for this reason alone. It was thought that electrical engineers should work out new methods of overcoming the difficulties indicated. Dr. Wall explained that the main object of his contribution to the question was to outline an alternative system which would permit the use of alternating-current generators driven directly from the turbines, and which would enable a considerable saving in capital outlay to be effected. Dr. Wall based his scheme on the characteristic phenomena of quarter-wave transmission. He proposed to generate alternating current at such a frequency that the length of the transmission line at one turbine speed—viz., the lowest—would be equal to or approximately equal to one quarter the wave length of the waves of potential difference and current which would be established in the line. As the speed of the turbines increased, the frequency of the generated alternating current would increase correspondingly, and, if the excitation was constant, the generated E.M.F. would also increase correspondingly. As the frequency increased, the wave length decreased, so that, if at the lowest speed the length

* No. II. appeared September 16th.

of the line was one-quarter wave length, then at double this speed the length of the line would be one-half wave length. Assuming constant current at the receiving end of the line, it was shown that, notwithstanding the rise of the generator voltage as the speed rose, the voltage at the receiver's end of the line would remain constant. The arrangement thus resulted in an alternating-current supply at the receiver's end of the line of constant voltage and variable frequency.

The linking up of the smaller water powers in Scotland, which has been discussed on previous occasions, was the subject of a short paper by Professor F. G. Baily. Under the scheme outlined, the small rapid streams and waterfalls of the high uplands and the rivers of the long, gently sloping valleys, would be utilised through small hydro-electric stations. The stations would be quite small, from 50 to 300 horse-power, in order to avoid the costly work of building large dams and pipe lines, and the plant must be simple and robust to obviate the need of skilled superintendence. Each turbine would drive an induction generator which, without any control or adjustment, would supply electric current to the mains in proportion to the water power available, and thus up to the limits of the output of the turbine would convert all the power of the stream, large or small. The starting up was so simple that it could be controlled from a distant central point. The general arrangement of the scheme would consist of a set of electric mains running out from a large town with a steam-driven central supply station, following the course of the river and branching at its tributaries until further extension became uneconomical. At all suitable points the small stations would be erected —being merely a hut with turbine and dynamo, feeding their quotum of power into the system. In the valleys a succession of small dams would be built, the turbine house being part of the dam and the steeper section of the system would have short lades and pipes to the turbines. The dams would serve to store water in times of drought. It was anticipated that the electric mains, which would not only serve as collectors but would be used as distributors, would be used to link all the farms, villages and small towns in any particular area on to the system. The central station would have a reserve which would ensure regularity of supply. Here would be required some special plant to make provision for a supply of magnetising current to the small dynamos, but even this could be arranged for by water-driven alternators set at a selected central point. The essential features of the scheme were, the author said, the cheapness and simplicity of the small stations, the low cost of supervision and the large percentage of the possible power that would be utilised.

Electric Supply Problems.

The programme of super stations which is now being framed for the new electric supply system has invested the problems associated with large electric units with fresh interest.

Mr. S. Parker Smith, who presented a paper on the subject, expressed the opinion that units of 25,000 to 35,000 kilowatts, were probably large enough to give good all-round economy without involving too much capital expenditure in spare plant. In no other direction had such progress been made as in hydro-electric work, and heads of 3000ft. and units of 20,000 horse-power were, said the author, becoming quite common. The greatest difficulty in constructing alternators for hydro-electric plants was the need of safeguarding them against over speeds, which varied from 80 to well over 100 per cent. The difficulties of rotor construction had increased with the higher outputs demanded. Three thousand revolutions per minute had become almost standard for 50-cycle machines, and outputs up to 20,000 k.V.A. were now practicable in spite of the fact that peripheral speeds were as high as 25,000ft. per minute. The solid rotor was preferred to any form of built-up construction, but for large four-pole rotors, weighing 35 to 45 tons, some form of built-up construction appeared to be necessary. In stators, ventilation problems had been accentuated by the greater losses. For large sizes neither simple axial nor simple radial ventilation was sufficient, and water cooling was being attempted. Station engineers were not yet satisfied with the methods adopted for cleansing the cooling air, and the expedient of passing the air through a refrigerator was being tried. In the Sohneider stator the water was first passed through the refrigerator used for cooling the circulating air. The end windings called for special consideration, but it had been found by experience that turbo-alternators could safely withstand sudden short-circuit conditions. The continuous-current turbo-generator might be regarded as dead, but the slow-speed alternator, as a result of the development of the internal combustion engine and the adoption of reduction gearing, had again assumed a position of importance. There was keen competition at the present time between slow-speed generators driven by steam turbines through reduction gearing and the combination of turbo-alternators with rotary converters. For large powers, the latter were probably cheaper and more economical, but for small powers the geared generator appeared to many to be the ideal arrangement. Mercury rectifiers were a comparatively recent innovation, and it remained to be seen what influence they would have, particularly when their cost was reduced. The difficulties connected with the design of rotary converters for 50 and 60 cycles had been to a great extent overcome, but it was difficult to build rotary converters for high pressures. Thus, at 50 cycles, 1000 volts was about the limit, whereas station engineers asked for 1500 volts at 50 cycles. This had been done by the Oerlikon Company, but ordinarily it was necessary to use either motor generators—two rotary converters in series, motor converters or mercury rectifiers. The last-named were now being made in three sizes—300 ampères, 600 ampères and 1000 ampères, at voltages up to 1500.

A typical modern electric station—although the first units to be installed, which are about to be delivered by Brown, Boveri and Co., are only of 10,000 kilowatts normal output—was described in a paper by Mr. S. B. Donkin. The author was absent through illness. The station described is that being built by the Edinburgh Corporation at Portobello. The plant for the station was, it was stated, such that at normal full load the overall thermal efficiency should be 21 per cent., the coal expenditure being equal to an expenditure of 16,300 B.Th.U. per kilowatt-hour. Features of the equipment on which stress was laid were the extent to which mechanical appliances had been introduced to save labour costs and the system of boiler-house control based on that devised by Myers. Another interesting part of the work described was the construction of the tunnels by which the water supply will be drawn from and returned to the sea. Experience with somewhat similar tunnel schemes on the Thames had proved that the cost of tunnelling was less than the cost of laying pipes down the foreshore, owing to the fact that a good deal of the work would have had to be carried out below low water tide level.

Three tunnels, each 1560ft. long, of 9ft. internal diameter, were decided to be necessary, and two of them, it was stated, had been completed, and the sea shafts constructed. In sinking the shafts at the sea end a great deal of work was involved. The foreshore, it was explained, was covered with a layer of sand some 15ft. thick, and under this was the boulder clay into which the tunnels were driven. In order to ensure a satisfactory seal in the boulder clay for the sea shafts, the sand was dredged, and in one case a rectangular shield and in the other case a circular cylinder larger than the actual shaft was lowered into the hole so as to rest on the boulder clay. The shafts were built up on temporary wooden stagings and lowered ring by ring into position inside these shields until the top reached a level some feet above high tide. The annular space between the shield and the shaft was next packed with clay and clay bags in alternate layers and rammed tight. The shafts were then loaded and a diver worked at the base with water jets until the shaft sank a few feet into the boulder clay and became water sealed. The water inside could then be pumped out and the shafts completed in a downward direction by underpinning. Means of preventing the accumulation of mussels on the inside of the sea shafts and of the tunnels had been investigated. The probable solution would be to raise the temperature of the outgoing water to 120 deg. Fah., which, it was believed, would kill the mussel spat.

The area of supply suggested for the station in connection with which an application had been made to the Electricity Commissioners was bounded by Linlithgow and Bathgate on the west, by North Berwick or Dunbar on the east, and by Penicuik or Gorebridge on the south. Sufficient space was available for a generating station having an ultimate capacity of 100,000 kilowatts, as well as sites for coal aidings and by-product recovery plant.

Mid-Scotland Ship Canal.

The features of the two plans for a ship canal between the Firth of Forth and the Clyde either by what is known as the direct or the Loch Lomond route are familiar to readers of THE ENGINEER from the special articles published at the time the scheme was before the Admiralty for consideration three years ago—see THE ENGINEER, November and December, 1917, and February and March, 1918. It was considered desirable, however, to have a fresh discussion of the subject before the British Association, and Mr. D. A. Stevenson, who has been closely associated with the engineering side of the project, was asked to open the discussion, which took place before a joint meeting of the Engineering and Geological Section.

Mr. Stevenson said it was over thirty years ago that his firm made a report on the possibility of forming a ship canal on the lines of the existing Forth and Clyde barge canal. As the result of the investigation then made they recommended the adoption of a route up the valley of the Forth through Loch Lomond and down Loch Long. The estimate for the work, if carried out to suit the requirements of the Defence Committee, was, at pre-war rates, £24,400,000, while a canal to suit the requirements of commercial vessels, 70ft. wide at the bottom and 31ft. deep, would have cost £12,200,000. It was not possible to form a reliable estimate of what it would cost to construct the canal during the next few years.

It was a mistake to suppose that the shipowner would be the chief gainer by the construction of the canal; it was the manufacturer, the general trader and the public generally who would reap the principal benefit by having goods transported at lower rates. The supineness of public opinion on the subject was easily accounted for. There was a general belief that if the scheme possessed the merits which its advocates claimed for it, those responsible for the policy of the ports of Glasgow, Leith and other commercial centres would have taken greater interest in the project. It had to be borne in mind, however, that the scheme was not of paramount importance for any one port, or even any group of ports, but for the business community as a whole. As to the strategical advantages of the canal, they had been admitted by the Defence Committee, and the canal, had it been in existence, would have been of immense importance during the Great War.

The views of at least a section of the shipping community do not coincide with those of the advocates of the canal. Mr. Salvesen expressed the opinion that from the commercial standpoint the scheme was absurd and impossible, and that a ship using such a route for a voyage from Glasgow to the Baltic and back would be mulcted in higher charges than if she used the all-sea route. No mid-Scotland ship canal could compete with the existing system of landing goods at the local ports and using the railway for distribution. Mr. H. M. Cadell also opposed the scheme, partly on the ground that the work of construction would flood collieries on the proposed route. In winding up the discussion, the chairman, Dr. Flett, suggested it was a case for a Government inquiry.

Wireless Telegraphy.

A description and demonstration of two new negative resistance devices for use in wireless telegraphy were given by Mr. John Scott-Taggart.

The author, in giving a short account of the uses of negative resistance, said it was mainly due to Duddell's appreciation of its value that we owed many of the modern achievements in radio-communication. The chief value of a negative resistance was that it was possible to neutralise the resistance of long stretches of telegraph cable, while wireless signals could be amplified a thousand times by the use of a single negative resistance valve. The main use of such a valve was, however, in the production of continuous oscillations for use in wireless transmission or reception by the beat method. The negation valve which he had introduced two years ago had now attained some commercial importance. It might perhaps be briefly described. A thermionic valve was arranged having two flat anodes one on each side of a filament. Each anode was connected through an anode battery to the filament so that the electrons emitted by the filament, when it was heated to incandescence, were distributed fairly equally between the two anodes. A control electrode, which might be a flat grid, was also arranged within the valve between the filament and one of the anodes. This latter anode was called the "diversion anode," while the first one was termed the "main anode." If the relationship between the electron emission and the anode voltages was suitably arranged the total of the anode currents could be made approximately equal to the electron emission. A saturation effect was thus obtained. Under such conditions, if the grid were made more positive with respect to the filament, electrons were diverted from the main anode to the diversion anode, with a consequent reduction of the current flowing in the main anode circuit. In the negation, as preferably used, the main anode was connected to the grid so that when the main anode voltage was increased, electrons were diverted from the main anode and the main anode current decreased. Hence the negative resistance effect. The applications of the device were already numerous and varied, but its principal use was as a generator of continuous oscillations for the transmission or reception of wireless waves. It could also be employed for receiving spark signals by reducing the effect of positive resistance. As a local oscillator it could be used on all ranges from 600 m. to 20,000 m.—the usual commercial range—without any complicated switching arrangements.

Another device having negative resistance characteristics, which was described by Mr. Scott-Taggart, makes use of two three-electrode valves. One of these, it was explained, acted as a conductor of current and the other as a phase-reverser. The circuital arrangements were, it was shown, such that when a positive potential was applied to the anode of one of the valves a negative potential was given to the grid, thus giving negative resistance characteristics. In the course of the demonstration given by the inventor a wireless message of greeting was received in the meeting room from the Admiralty station at Aberdeen, and signals were received from the Eiffel Tower and other stations.

Air Lift Pumps.

Dr. John S. Owens, who presented a paper dealing with air lift pumping, said his object was rather to call attention to the possibilities of the air lift pump than to indicate any final conclusions as to the best design of such pumps. Experience had shown that the air lift was usually an extremely wasteful method of pumping, owing to its low efficiency. This had militated against its use; but there could be little doubt that if the efficiency could be increased there was an

immense field for the use of such pumps. He had made some experiments with the object of producing the best design of pump for lifting acid mine liquors in the mine of San Domingos, in Portugal. The work that had been done convinced him that the low efficiencies usually obtained were not an essential part of the method, and he had been able to get pump efficiencies with air lifts of between 60 and 70 per cent.

Causes of loss in air lift pumps could be grouped under the following heads:—(1) Slippage losses, due to relative motion between air bubbles and water; (2) losses due to friction of the mixture of air and water in the rising main; (3) friction losses incurred by the flow of water before air was admitted; (4) energy discharged in the kinetic form with the water and due to the velocity of discharge.

The losses under headings (3) and (4) were definite quantities and could be said to be more or less under control. It was in connection with those under (1) and (2) that there appeared to be a good opportunity for increased economy.

Many experiments had been made already dealing with the question of submergence, and it had been definitely established that there was a most suitable value for this, the best efficiency being obtained with a submergence of about 70 per cent., that was when the length of submerged pipe was 70 per cent. of the total length—submergence + lift.

With regard to the loss arising from slippage, it was clear that a high velocity of the mixture tended to a low slippage loss. The loss due to friction of the mixture in the eduction pipe was often considerable. It varied directly with the square of the velocity, while those from slippage varied inversely with the velocity, and the aim of the designer was to fix a definite value for the velocity where the sum of the friction and slippage losses would be at a minimum. It was a well-established characteristic of air lift pumps that the highest efficiency was obtained at one particular delivery. The most suitable value for the submergence was best found experimentally, but seemed usually to be between 65 and 75 per cent. An appreciable effect was, however, to be obtained by very small variations in submergence. Taking v as the mean square of velocity in the pipe and f as the coefficient of friction, tests gave a value of $f = 0.025$ in a 6⅝in. pipe with v mean $= 13.3$. The effect of nozzle diameter was found to be very slight, the governing factor being the rate of flow of air through the orifice. Describing the air lift mine pump, the author said that the installation was in two lifts—one of which raised the water from the 210 m. to the 180 m. floor, and the other raised the water to the 150 m. floor. It was found that the efficiency of the upper lift pump varied between 56.6 and 64.13 per cent., and that of the lower lift pump from 52.5 to 66.1 per cent. The throat piece with the smallest diameter was found to give the highest efficiency—a result which was somewhat unexpected. The probable explanation was the effect on the size of bubbles. The smallest throat yet tried had a diameter of 3¼in., and this was being experimentally reduced to 2½in. This installation had replaced a three-throw electrically driven ram pump which had been a constant source of trouble.

SEAPLANES.

Progress in seaplanes has been less marked than in aeroplanes, and the short contribution on the subject, presented by Squadron Leader A. J. Riley, was therefore welcomed. Dividing seaplanes into the two main classes—the float type and the boat type—the author emphasised the advantages of the former type, which could, of course, be easily handled on shore. Their design was also favourable to stability both on the water and in the air, and they could also be readily converted into aeroplanes. Dealing with the various arrangements of floats, he referred particularly to the employment of a single large central float with two small floats attached to the wing tips. Although it had not hitherto met with much favour, this design was associated with a much clearer field of view for the pilot than the arrangement of two main floats with or without a tail float. The real advantage of the boat over the float type of machine was the lighter form of construction, giving a lower air resistance, and the result was that the boat type had been built in large sizes. It was necessary to give careful attention to the clearance between the tips of the propeller blades and the water line, and 3ft. had been fixed as the minimum which could be safely accepted, although it was associated with a high thrust axis, which had obvious disadvantages.

Time did not permit the author to present the paper except in abstract, and he was compelled to deal very briefly with the design of hulls for boat seaplanes. Some cross sections of different forms of hulls which he showed, as well as resistance curves obtained from tests at the Teddington tank, brought out several features of interest. The full paper contained a table giving design data for the hulls of boats. The designs dealt with included the F.B.A., Norman Thompson N.T.O 2 B, A.D. Boat, F 3, Phœnix Cork No. 1, Felixstowe Fury, Vickers Valentic, and two Fairey Atalantas, one of the Linton Hope and the other of the Camper and Nicholson design. These vary in length from 26ft. 2in. to 64ft., and in displacement from 2000 lb. to 32,000 lb., the largest being the Fairey Atalantas.

The Proposed Hudson River Bridge at New York.

THE erection of the great highway and railway bridge to span the Hudson River at New York will, if it be carried out, add one more to the list of huge constructions which form a conspicuous feature in the engineering and architectural activities of America. If, however, the proposed bridge is of a size which may rightly be called stupendous, so is the problem of transportation which it is intended to solve, and the decision to bring the larger part of the goods and passenger traffic into New York by means of one great structure rather than by way of many smaller structures was based upon a careful consideration of the fundamental economics of the problem. Topographically considered, Manhattan Island, which is the business and civic centre of greater New York, is not well placed for the solution of its rapid transit problems. To the south are the broad waters of New York Bay; to the east is the East River, some 1200ft. to 3000ft. in width; to the west is the Hudson River, which varies from 3000ft. to 4000ft. in width; and to the north is the smaller Harlem River, which cuts across the peninsula from the Hudson to the East River, and thus constitutes Manhattan an island. The Harlem River has never proved a serious obstacle, since it is easily crossed by bridge or tunnel. Travel across the East River, during the first one hundred years of the life of the Republic, was entirely dependent upon ferry service, and it was not until the opening of the well-known Roebling suspension bridge in 1883 that Brooklyn and Long Island were placed within easy communication with Manhattan. Some twenty years later the Williamsburg Bridge, with a main channel span of 1600ft., or 5ft. more than the span of the Brooklyn Bridge, was opened, and at intervals of a few years there were completed the Manhattan suspension bridge, of 1475ft. span, at Canal-street, and the Queensborough cantilever bridge at Fifty-ninth-street. A later crossing of the East River, built purely for goods and passenger trains, was effected by the erection of the Hellgate railway bridge, a massive four-track steel arch structure, with a channel span of 1000ft. The construction of these bridges had an immediate effect upon the growth of the city of Brooklyn and Long Island, as may be judged from the fact that there is to-day a population of 2,500,000 on that side of the river.

Undoubtedly, the greatest physical obstacle to the spread of New York City's population and to the economical handling of the vast amount of goods and passenger traffic which seeks the city as a terminus or passes through the port of New York on its way to and from foreign countries, has been the broad stretch of the Hudson River. Of all the leading trunk line systems, two only—the New York, New Haven and Hartford Railroad and the New York Central—have always had direct access to Manhattan Island. The other trunk lines, with the exception of the Pennsylvania Railroad, which has built its own tunnels beneath the Hudson River, are brought to an abrupt stop on the western shore of the Hudson River. To reach Manhattan, passengers must change either to ferries or to rapid transit "tubes," of which latter there are two, one reaching Manhattan at Christopher-street and the other serving the "downtown" district in the neighbourhood of Cortlandt-street. So far as passenger service is concerned, this journey involves change and delay on the Jersey side. So far as goods are concerned, the present condition of things is simply disastrous. To distribute the incoming goods—and it must be remembered that about one-half of the foreign trade of the United States passes through the port of New York—it is necessary to resort to the use of steam lighters—that is, barges, self propelled by steam—or of barges that are towed to their various destinations by tugs. Because of the excessive amount of handling and re-handling which is necessary before the goods reach the merchant, the factory, or the steamship, this method has always been very costly. Furthermore, the present system is fraught with great peril to the comfort and even the health of the inhabitants of the city, as was proved in the cold winter of 1917–18, when, although there was a vast supply of coal accumulated on the Jersey City front, it was impossible to get it across to New York because the various slips and pier basins were choked with ice. Economically considered, the present method of handling goods and minerals at New York City is very extravagant; for it is a fact, which has frequently been stated on high authority and has never been disputed, that it costs as much to move a ton of goods from the railway classification yards in Jersey City to its destination in New York as it does to haul it from points 500 miles or more inland.

The many disabilities, both as to passenger and goods traffic, under which not only Manhattan Island but the whole of Greater New York has laboured were well known to the city authorities of an earlier day. The problem, so far as the East River was concerned, was solved by bridging—a gigantic undertaking if we consider the comparatively limited engineering and manufacturing facilities at the time when the first bridge was built. As soon as electric traction was developed to the point at which the hauling of trains through long tunnels became feasible, the Pennsylvania Railroad tunnels, followed later by the McAdoo rapid transit tunnels, were built below the Hudson River as a partial solution of that problem. But many years before the tunnelling of the Hudson River was rendered possible Mr. Gustav Lindenthal, who is recognised as being one of the world's leading authorities on long-span bridges, conceived the idea of solving the Hudson River problem by the construction of a single bridge of such great capacity that it could provide for all the railway goods and passenger traffic that was destined for New York City. That was as far back as 1888. His plans were laid before the Pennsylvania Railroad Company as being the one that was most vitally interested in securing unhindered access to New York, and the proposal met with the enthusiastic support of Mr. Rea, then one of the leading officials, and to-day the president of that line. The great panic of 1893, which reacted so disastrously upon the railways, postponed the construction of the bridge. Later, in 1914, when the financing of the enterprise was well under way, the world war rendered necessary another indefinite postponement. To-day, however, a strong corporation, which includes the leading railway, banking and other financial interests of the city, and has the endorsement of the Governors of New York and New Jersey and of the recently created Joint Port Authority, has been formed and there appears to be good prospect of the project being carried through to a successful consummation. It is estimated that the formation of the working organisation, both financial and engineering, and the preparation of the complete working plans, will occupy from eighteen months to two years. The erection of the bridge itself can, it is considered, easily be done within a period of five years. The total cost of the bridge at present prices is estimated at 110,000,000 dols.—nominally, say, £22,000,000.

The War Department of the United States Government prohibited the placing of a pier in the centre of

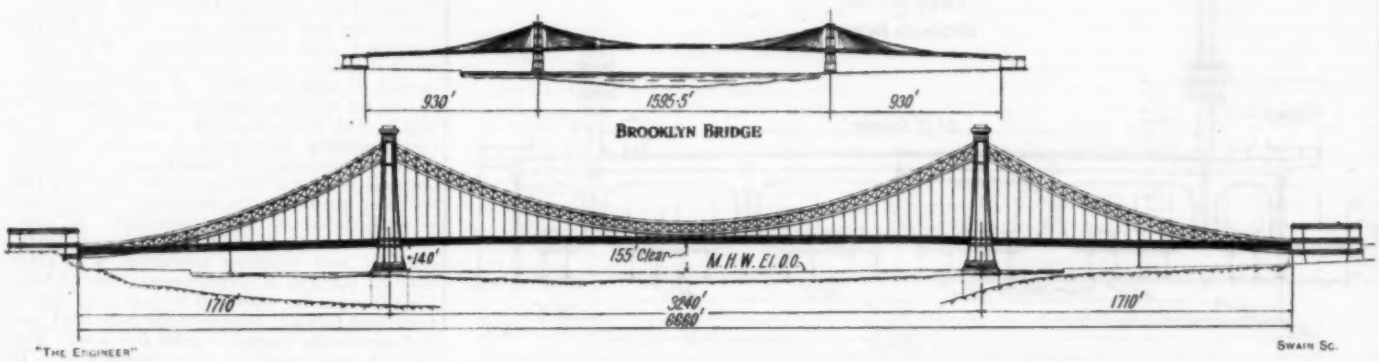


FIG. 1—OUTLINE OF PROPOSED HUDSON RIVER BRIDGE CONTRASTED WITH BROOKLYN BRIDGE

the Hudson River, and indeed the physical conditions themselves render a river pier impossible. The bed of the river consists of an ancient glacial gorge filled in to a great depth with an accumulation of sand, gravel and mud. It would be necessary to go down to impossible depths to reach a firm rock foundation. As it is, the foundations of the main towers on each side of the river will have a depth of from 140ft. to 160ft. below mean tide level. The proposed bridge—an outline of which is given in Fig. 1—will consist of a central span, 3240ft. from centre to centre of towers, and two shore or approach spans, each 1710ft. in length from the centre of the tower to the base of the abutment. The bridge will be of the suspension type and the floor will be carried by two pairs of chain cables, each pair being arranged in the same vertical plane and strongly braced, so as to form an inverted truss 60ft. in depth. The horizontal distance between the cables will be 160ft. from centre to centre. Each cable will consist of eighty eye-bar chains, arranged in three banks, one above the other. The diameter of each cable as assembled will be about 10ft. 6in. This may be compared with the steel wire cables of the Brooklyn Bridge, which are 15in. in diameter. The eye-bars will be 60ft. to 70ft. in length, according to their position in the cable, and each cable will be enclosed in a bronze or copper tube 15ft. in diameter. The tubes will be of sufficient size to permit workmen to make periodical inspections of the chains, and their object is to protect the chains from the weather and to extend the period for which a single painting will suffice.

The main towers, the legs of which, eight in all, will be of massive box section 8ft. square and strongly braced together, will be carried up to a height of about 775ft. above mean high water. As a protection against the weather each tower will be entirely enclosed with smooth-dressed light grey granite.

In the base of each tower will be an electric power station which will provide current for the operation of the trains from the Jersey yard, to and across the bridge, and down a marginal elevated railway on Manhattan.

Advantage is to be taken of the great height of the towers to establish a wireless station at the top of each by stringing a set of aerials across the gap of 3200ft. The aerials will be cross connected to give them rigidity against wind pressure. The average height, 750ft., of the wires—the sag will be 150ft.—and the great span will provide a capacity which will render this one of the most powerful of the world's long-distance radio stations.

On the landward side the cables will be made fast to massive masonry anchorages measuring 375ft. in width by 400ft. in length and 220ft. in height. Upon each anchorage will be erected two office buildings, each 280ft. in height. The modern fast-running elevator will render these buildings fully available for business purposes, and their rentals will add considerably to the revenues of the bridge.

The enormous growth of automobile and motor truck traffic has been one of the strongest predisposing motives which have led the leading capitalists of the city to undertake the construction of the bridge as a private venture. It is proposed to devote practically the whole of the upper deck of the bridge, 220ft. in width, to automobile and motor truck traffic, and to reserve the lower deck for the service of steam railway and rapid transit trains. For the latter purpose ten sets of railway lines will be provided. On the upper deck, on the extreme outside, will be two 15ft. pathways, and adjoining them two tramway lines. Between the cables will be a vast unobstructed boulevard 155ft. in width. This upper deck will be built of steel buckle plate flooring overlaid with asphalted concrete. A cross section of the proposed bridge is given in Fig. 2, with, for the sake of comparison, a cross section of Brooklyn Bridge. The sides and bottom of the lower deck of the bridge will be enclosed, so that the whole of the floor structure will be completely protected from the weather and painting will be reduced to a minimum. It may be remarked here that the re-painting of a great bridge like that proposed is the most costly item in its maintenance. Were the structure to be exposed to the weather, like the Forth Bridge, it is estimated that the annual bill for painting alone would reach nearly 500,000 dols.—say, £100,000. In the new bridge the amount of enclosure of the steel work of the tower, the cables and the floor which is contemplated will leave only about 5 per cent. of the steel exposed directly to the wind and weather.

The bridge itself forms only part of a comprehensive project for the handling of passenger and goods traffic, which includes a large goods classification yard in Jersey City, a Union Station in Manhattan, and a two-deck overhead railway track extending along the margin of the Hudson River from about Fifty-eighth-street down to Fulton-street. Co-operatiug with the classification yard and forming part of the equipment will be a large fleet of motor trucks, which will load up with the smaller mixed goods, taking them direct from the railway wagons and bringing them across the bridge for delivery at the warehouse, the factory or elsewhere as may be desired. The re-classified wagons, carrying goods in bulk, will be made up into trains and taken across the bridge and down the marginal elevated railway, where they will deliver their loads either to special warehouses abutting upon the railway, direct to the steamships at the piers, or elsewhere in Greater New York. The passenger traffic, including through trains from the West, will be brought down by easy gradients from the bridge to a large union station situated not far from the Manhattan terminus of the bridge.

The accompanying illustrations, drawn to scale, serve to give an adequate impression of the proportions of the proposed bridge. The main towers, which measure 200ft. by 400ft. at their base and 100ft. by 200ft. at their summit, will be 50ft. higher than the Woolworth tower. For our illustrations we are indebted to the *Scientific American*.

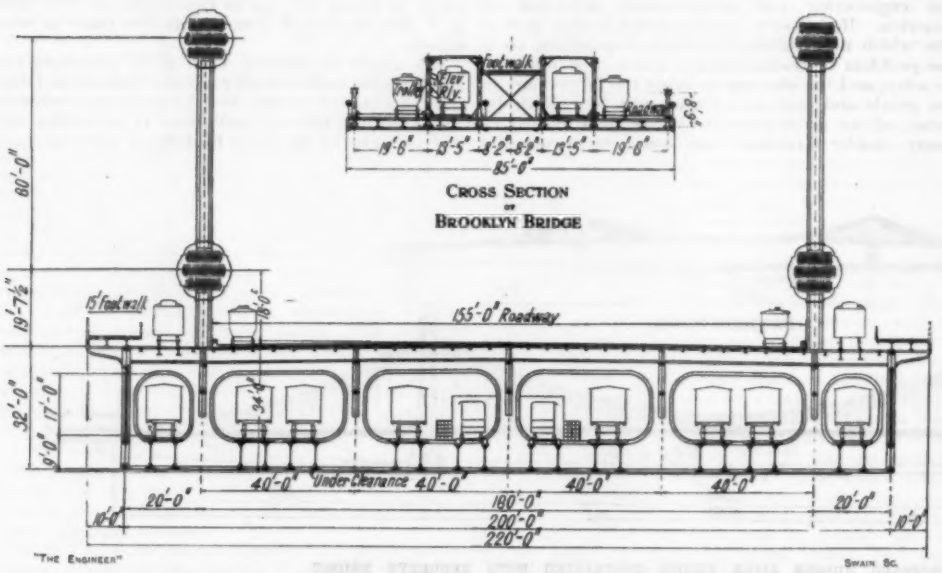


FIG. 2—CROSS SECTIONS THROUGH PROPOSED HUDSON RIVER AND BROOKLYN BRIDGES

Institute of Metals.

AUTUMN CONFERENCE IN BIRMINGHAM.

No. I.

THE second conference which the Institute of Metals has held in Birmingham took place on Wednesday and Thursday of this week. The first Birmingham meeting was held in the year 1908, and actually marked the beginning of the activities of the Institute. Those who can recall the earlier gathering in the industrial capital of the Midlands—and there were not a few attending this week's meeting who were present thirteen years ago—will have marked with much satisfaction the progress which the Institute has made in membership and influence. The conference over which the late Sir William White presided in 1908 was a small affair. The band of pioneers who had founded the new Institute to promote research on non-ferrous metals and to provide a meeting-ground for scientists, manufacturers and users of these materials, had high hopes of attaining success, and they brought to bear on the task both knowledge and enthusiasm. The large attendance at this week's meetings and the rapid increase in the membership of the Institute are signs—although not the only ones—that the founders are in a fair way to achieve their object. The Presidents, from Sir William White down to Sir George Goodwin, have been worthy representatives of either science or practice, and under the guidance of the distinguished men who have filled the chair the Institute has done much useful work, among which the research into the causes of corrosion in condenser tubes and the general investigation of the baffling problem of corrosion in metals occupies a conspicuous place. If at times it has seemed that the papers submitted for reading at the Institute's conferences have not adequately represented the practical side, this has perhaps arisen from the readiness of scientific investigators and the unwillingness of manufacturers to lay all their cards on the Conference table. Even judged from this aspect, however, it can be claimed that the work of the Institute has done something to break down the barrier behind which manufacturers, and sometimes users, entrench themselves and refuse to be cajoled into the open.

A fairly comprehensive programme had been drawn up for this week's meeting. The large attendance filled the Examination Hall of the Municipal Technical School, Suffolk street, when the Lord Mayor of Birmingham welcomed the Institute on its second meeting in the Midland city, which is appropriately the chief British centre of the non-ferrous metals industry.

The rest of the morning was occupied with the reading and discussion of papers.

Members and visitors were subsequently entertained to luncheon by the Metal Trades Associations, seven in number. The toast of the Institute of Metals was proposed in a happily phrased speech by Mr. John W. Earle, chairman of the Associations, and acknowledged by the President, Engineer-Vice-Admiral Sir George Goodwin.

In the afternoon a visit was paid to Birmingham University, a brief inspection being made of the various departments. In the Chemistry section original investigations are now being carried out by post-graduate students. The problems at present under review are concerned principally with two main branches of the subject, the chemistry of coal tar dyestuffs and their intermediates, and the occurrence of residual affinity and co-ordination in chemical compounds. The results obtained in the former research have reference both to the question of producing fast and brilliant colours and to the problems connected with diazo chemistry. With respect to residual affinity and co-ordination, research is being carried on with the object of throwing further light on the far-reaching principles enunciated by Werner which, still the subject of controversy, are finding ever-increasing application in modern chemistry.

In the metallurgical department, by adapting an open-air ward and adding a new building, provision has been made for the semi-large scale plant to be accommodated in close proximity to the main metallurgical department. In this new section are crushing and weighing machines, a reverberatory roasting furnace, a reverberatory melting furnace, a blast-furnace for lead and copper ores, and a heat treatment furnace, together with coke-fired, gas-fired, and electrically heated crucible furnaces. The addition of other units is in contemplation. In the engineering sections the departments of civil, mechanical and electrical engineering are separately housed, each under the charge of a professor of one of those subjects. The department of civil engineering takes, in addition to the professional subject, strength of materials and hydraulics, and is well equipped for experimental teaching in these subjects. The most noteworthy feature is the 350-ton testing machine capable of testing specimens up to 27ft. in length, which is the largest machine in Great Britain. There are in addition a number of 50-ton and 100-ton machines. In hydraulics there is a complete set of experimental pumps, weirs and measuring tanks. The department of mechanical engineering serves a dual purpose, as in it is contained the boiler plant and the whole of the electrical generating plant for the University. The engines and boilers include all the leading types of prime movers which are in commercial use, so that the student in the course of his training is made familiar with current forms. A strong feature is made of gas, oil, and petrol engines, of which the University possesses a very wide range of forms, and these enable post-graduate research work to be carried out with great facility.

The University workshops, which provide an important part of the training in the first two years of the course, are intended to serve as an introduction to practical problems. They comprise foundry, smiths' shop, pattern shop, and machine shop, and are fitted with the latest types of machinery. It is found that students who have been taking a two years' course in the workshops do, when they proceed to commercial works in the latter portion of their course, acquire knowledge much more rapidly than those unfamiliar with tools and workshop methods.

The mechanical department specialises in scientific research in the internal combustion engine, and the post-graduate school in this subject is growing; it is hoped that in the future this side of engineering research will become more extensive by the assistance of the Department of Scientific and Industrial Research.

The electrical engineering department has a large laboratory containing examples of nearly every type of electrical machine in sizes sufficiently large to compare with commercial types.

On Wednesday evening a civic reception was held by the Lord Mayor in the City Art Gallery.

A Seven-Day Journal.

London Telephone Developments.

ADVANTAGE was taken by the Postmaster-General at the formal opening of the new London telephone Toll Exchange to make a statement on the general position of the telephone system. He said it was intended to bring into the Toll Exchange an area within 50 miles of the Metropolis. Associated with this development as the result of the removal of Toll lines from the trunk exchange would be an improvement of long-distance communication. Special attention was now, Mr. Kellaway added, being given to the improvement of the trunk service. The difficulty arising from the shortage of raw material for telephone work was being rapidly overcome and the construction ot the underground trunk system pressed forward. Efforts were also, it was explained, being made to meet the demands for service which were being made upon the department, although it was admitted that there were between 16,000 and 17,000 applications still outstanding which had been refused by reason of the lack of plant owing to the cessation of manufacturing operations during the war period.

Seaplane Floating Dock.

THE floating took place a few days ago at Sheerness of the seaplane floating dock which has been built at the dockyard for the Air Ministry. The dock, which is designed to accommodate two large modern aeroplanes, has a length of 143ft. overall and a breadth of 51ft. 1in., with a lifting capacity of 200 tons.

Factory Lighting.

THE Home Office pamphlet which deals with various aspects of the lighting of workshops and factories is a useful publication, and should be in the hands of all those who are responsible for this section of factory equipment. Mixed up with a certain amount of platitudinous advice as to the influence of good lighting on efficiency and on the health of the workers are some good hints on the subject of uniform illumination and glare and the shading of light sources. It is quite true—and stress is laid on this point—that a careful combination of localised and general lighting not only tends to increase output but reduces the risk of accident to workers. Local lighting demands, it should be remembered, an adjustable light and reflector both within 2ft. of the operator, and general lighting an overhead light not more than 7ft. from the worker and fitted with one of the new types of translucent shades. Not the least valuable section of the pamphlet, which can be bought for fourpence, is that devoted to tables of illumination tests and lighting systems. There is also a catechism for employers, to which many would fail to find the right responses.

Motor Liner.

WITH the putting into service in the immediate future of the British India Company's new liner for service between London and Calcutta an important addition will be made to the list of motor ships. The vessel, which has been named the Domala, is of 9000 gross tons and is fitted with engines designed to develop 4600 horse-power on a fuel consumption of 16 tons of oil per day, which, at the present price of oil fuel, should, it is believed, represent an appreciable saving in fuel costs. Those who have had an opportunity of inspecting the Domala have been much impressed by the saving in the space devoted to machinery. Two sister ships are at present under construction for the same owners.

New North-Eastern Car Sheds.

ALTHOUGH at the time of writing the contract has not been placed, the tenders for the new sheds at Gosforth for electric car stock have been received by the North-Eastern Railway. The intention at the outset is to provide accommodation for 120 cars, but the site for the sheds has been chosen with a view to extensions being made and to housing all the passenger stock used in the local services. The design approved for the first stage of the work is a steel and brick building over 700ft. long and divided into four bays, containing ten standing tracks. Repair shops and offices are also included in the scheme. The estimated cost, exclusive of the price paid for the land, is said to be between £200,000 and £250,000.

A Notable Railway Anniversary.

IT is eighty years ago this week since London and Brighton were first linked by railway. It was on September 21st, 1841, that the first train from London steamed into Brighton Station, the event being celebrated by the inevitable dinner, which was held at the "Old Ship." The pioneer service comprised seven down and eight up passenger trains, the express trains reaching their destination, after calling at four intermediate stations, in two hours. To-day there are thirty-four down and twenty-six up trains, with the "Southern Belle" and other expresses, making the journey in sixty minutes. Third-class passengers by these early services had very good reason to complain of the accommodation provided for them. While for the first-class traveller there were coaches somewhat on the lines of the present-day carriages, the third-class compartments were more like cattle trucks, often without roofs and seats, and divided only by an iron bar. So troublesome were the smoke, dust, and ashes that it was generally advisable to be armed with a stout umbrella. The actual cost of the line was £37,568 per mile, or nearly 60 per cent. more than the estimate. The utmost speed claimed for the line was 30 miles an hour, and indeed expert evidence was given against it in the House of Commons that it would be impossible to exceed 25 to 28 miles per hour. It was claimed also that the line would convey twice as many passengers as were then conveyed by coach, which numbered about 100,000 per annum. To carry this number in a single day would not be an extraordinary feat under modern conditions.

Wages and Employment.

THE review made in the last issue of the *Labour Gazette* shows that the percentage of unemployment is still high, although there was last month an improvement in many industries and notably in pig iron, tinplate, sheet steel manufacture, and the glass trades. Changes in rates of wages in industries for which statistics are compiled by the Department affected nearly 3,160,000 workpeople, of whom 3,070,090 sustained decreases while nearly 90,000 received increases. The net effect of all the changes was a reduction in weekly full-time wages of about £690,000. Since the beginning of 1921 changes in rates of wages reported to the Department have resulted in a net reduction of over £3,550,000 in the weekly wages of over 6,000,000 workpeople, and a net increase of about £73,000 in the wages of 320,000 workpeople. The total number of workpeople involved in all disputes in progress at any time in August—including those thrown out of work at the establishments where the disputes occurred, though not themselves parties to the disputes—was about 26,000, as compared with 1,127,000 in the preceding month and 86,000 in August, 1920.

Works Reopening.

CONVERSATIONS with those who are acquainted with industrial conditions in South Wales reveals the fact that the outlook in that area is much brighter. Several works—among them the Barry Works, Llanelly, and the Western and Pantyffynnon—have just been reopened after being closed down for nearly a year. It is to the credit of employers that manufacturing operations are being re-started, as it is known that the prices realised for tin-plates are below the cost of production at the present time, and the main object is to get going and to prevent the spread of unemployment. One of the greatest handicaps to the home tin-plate trade is the high prices at which steel bar is quoted, and it has been impossible to prevent the influx of foreign bars which are underselling the local product in the Welsh tin-plate trade. This feature of the situation is causing a good deal of anxiety, as the local steel works are by no means well employed.

Norway's New Trunk Railway.

THE opening of the trunk line between Christiania and Trondhjem is of interest to British railway engineers, not only on account of the character of the work involved, but by reason of the fact that the first link of the Norwegian trunk railway system was forged by Robert Stephenson in the early 'fifties of last century. The piece of construction which has now been completed was the conversion to broad gauge of the last section of the trunk road from Christiania. The broad-gauge route formerly terminated at Dombaas, about 180 miles from the capital, but the whole route from Dovre through Stören to Trondhjem has now been changed over. The scheme has involved protective works against avalanches of considerable magnitude, snow sheds and barriers having been constructed over a length of 41,000 yards. There is also a good deal of tunnelling. The cost of the works has been about 2¼ million pounds.

Gretna for Sale.

THE great cordite factory at Gretna is to be sold, lock, stock and barrel, if a purchaser can be found. As a single lot it is, of course, quite unique, comprising not only the townships of Gretna and Eastriggs and the great factories of Dornoch and Mossbend, but over 40 miles of private standard gauge railway with stations, a large mileage of sidings, and an extensive road system. Over 100 miles of mains have been laid for supplying water for domestic and industrial purposes, and total storage capacity of twelve million gallons has been provided. An electric supply station supplies current for both power and lighting purposes through three main transmission lines to the whole of the three areas, Gretna, Mossbend, and Dornoch. Four generating units of the most recent type have been installed, having an aggregate capacity of 4500 kilowatts, and it is said that under favourable conditions current can be generated for about a halfpenny a unit. Steam and hydraulic power plants have also been put down. The whole properties is claimed to be quite self-contained, and—in addition to the factories, plant and housing facilities—churches, a hospital, a bank, dancing halls, and picture theatres, as well as playing fields, already exist. There are obvious manufacturing requirements which could be met at Gretna, but the times are rather out of joint for a deal on the scale required, and Gretna may prove a drug on the market.

Future of British Aviation.

IN view of the despondent tone in which many who should know better refer to the position of British air services, Lord Weir's speech at the Scottish Branch of the Royal Aeronautical Society was a most refreshing dose of optimism. The cross-Channel services are, he reminds us, the key to the future development of the British aircraft industry, in which he has the utmost faith. We are really, Lord Weir thinks, making good headway, and if the advance has been too slow for some people the explanation is to be found in the financial situation, which has, however, been somewhat eased by the reduction in the price of petrol. This should make a considerable difference in running costs. The Government subsidy is to be regarded, we are told, as not only helpful, but in the circumstances generous. The onus of responsibility for development should now, in Lord Weir's opinion, rest upon private enterprise, and not on the Air Ministry. On that point there is room for difference of opinion, but those engaged in running air services will doubtless accept their fair share of responsibility for expansion.

Rhodes Scholarships.

THE disposal of the German portion of the Rhodes Scholarships has been the subject of careful thought. The matter has now been settled on satisfactory lines. A resolution which has been brought forward in the Council of State at Simla for the transfer of the German interest to India has been accepted by the Government.

The New Capital Ships.

IT is understood that no fewer than nine firms have been asked to tender for the new battle-cruisers. Four English firms, four Scottish firms, and the great firm of shipbuilders having its headquarters at Belfast are in the running for a contract which in each case will, it is estimated, run into a sum of about £8,000,000 and give employment to thousands of men. Many are already guessing at the destination of the orders, and others have definitely named the yards where the keels of the new mastodons will be laid. The assumption is that two Scottish and two English firms will obtain these valuable orders, and the firms likely to be preferred for work of this class will readily occur to those who are familiar with the great British yards. The fact that it would be possible to undertake the construction of the new ships in no fewer than nine private yards, while none of the Royal Dockyards could undertake the work without reconstructing the building slips, is a fact on which comment would be superfluous.

Murray Irrigation Scheme.

THE first section of the Murray lock and weir system, which will extend over a distance of more than 1000 miles, is reported from Adelaide to have been completed. The works form part of the great irrigation scheme which was sanctioned by the Commonwealth River Murray Waters Act, which is being carried out by the Federal and the State Governments, which have accepted responsibility for various sections of the work. The lock and weir on the Murray River just finished were put in hand by the South Australian Government, while the chain of locks on the Murrumbidgee, work on which is to be put in hand immediately, is the responsibility of New South Wales. The total cost of the scheme is estimated at £7,000,000.

The Shipping and Engineering Exhibition.

No. III*.

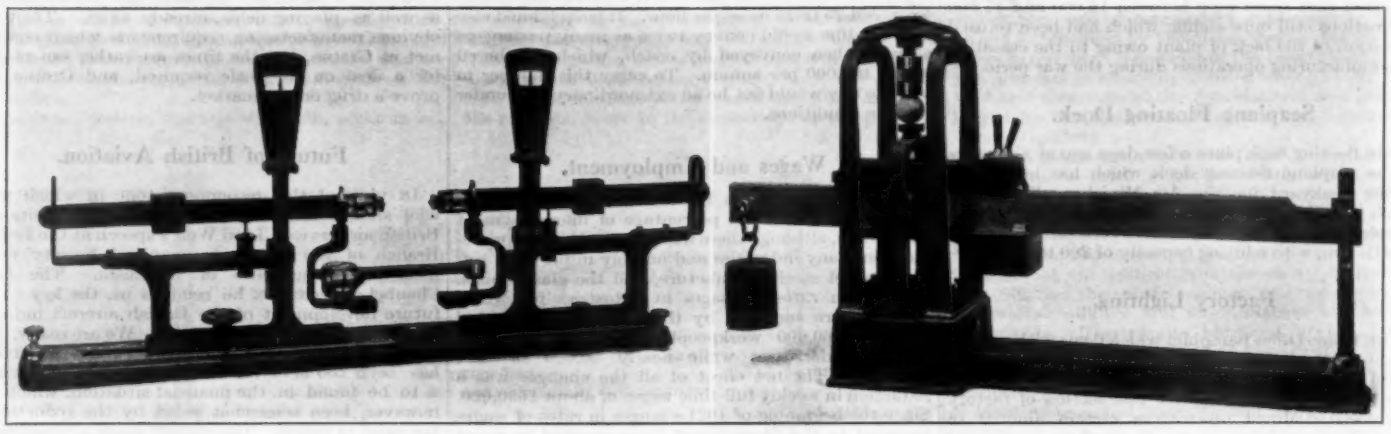
TESTING MACHINES.

ON the stand of W. and T. Avery, Limited, Soho Foundry, Birmingham, several interesting testing and weighing machines are exhibited. The connecting-rod balancing machine illustrated in Fig. 27 represents Messrs. Avery's most recent practice in this class of appliance. It is designed to weigh both ends of the connecting-rod simultaneously, and is intended to reduce the hitherto somewhat delicate job of accurately weighing the rods to a "production" basis. A common practice with internal combustion engine makers is to find simply the deadweight of the connecting-rod. Messrs. Avery's machine, permitting as it does the weight of each end to be determined separately, enables, by adjustment, the centre of gravity to be placed relatively to the ends similarly in all similar rods. The gross weight is, of course, determined by adding together the two readings shown on the separate weighing systems. The rod, it will be seen, is supported at the centres of the gudgeon and crank shaft pin holes on a pair of conical points projecting upwards from stirrups, suitable loose pins being inserted in the holes to receive the points of the conical supports. The stirrups are suspended from two separately hung arms, each of which is provided with a dash-pot, a balance weight and a pointer working against a quadrant scale engraved from + 2 to — 2oz. In use, the balance weights are adjusted to suit a standard rod. Thereafter succeeding rods can be rapidly passed through the machine, any discrepancies in their "end weights" being read off against the quadrant scales. The machine can be adjusted to accommodate rods ranging from 7in. to 16in. centre to centre.

The Avery machine shown in Fig. 37, page 320, is intended for statically balancing crank shafts, armatures, and similar objects. The object to be balanced rests with its shaft supported on vee blocks mounted on a cradle which is carried on knife-edges in line with the centre of the shaft. The object is turned on the vee blocks into various positions, and in each the degree of out of balance is determined by reading a pointer attached to the cradle and working against a fixed quadrant scale engraved in terms of inch drams.

Among the other exhibits on Messrs. Avery's stand is a golf ball testing machine and a proving apparatus for Brinell hardness testing machines. The proving apparatus consists of a steel-yard arrangement which may be attached to the Brinell machine and which enables the accuracy of the standard load of 3000 kilos. to be examined. This apparatus is scarcely necessary in a works possessing only one or two Brinell machines. Messrs. Avery are therefore prepared to use their apparatus for testing the accuracy of loading of Brinell machines submitted to them for examination. They tell us that they have found considerable errors in some machines recently sent to them for proving.

The golf ball testing machine—Fig. 28—is designed to afford golf ball makers an easy means of checking the work of the rubber thread winders. It is a simple machine consisting of a steel-yard and poise weight and a pair of platens between which the ball is compressed. A load up to 155 lb. can be applied to the ball. The compressive strain suffered by the ball is measured in thousandths of an inch by means of a scale and vernier at one end of the steel-yard. The machine can be used not only in connection with the testing of rubber thread wound balls, but also for examining and controlling the manufacture of solid core and gutter-percha balls. In Fig. 29 we reproduce two stress-strain curves obtained by means of the machine. Curve A was plotted from the readings relating to a tightly wound rubber thread ball, while curve B was obtained from a slackly wound ball. The considerable amount of hysteresis indicated is noteworthy. It may be added that Messrs. Avery find it best not to take the strain reading until 15 seconds after the load has been applied, for the reading tends to grow while the load is maintained.



FIGS. 27 AND 28—AVERY'S CONNECTING ROD WEIGHING AND GOLF BALL TESTING MACHINES

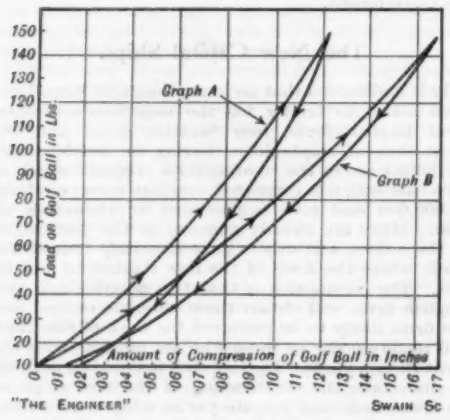


FIG. 29—GOLF BALL COMPRESSION CURVES

GAS-FIRED AND WASTE HEAT BOILERS.

The name "Bonecourt" is so familiar in connection with surface combustion that some visitors to the stand of Spencer-Bonecourt, Limited, may perhaps feel a little disappointed when they learn that the boiler there shown under steam is not equipped on the lines worked out some years ago by Professor Bone and the late Lieutenant McCourt. The position is, however, that the "Bonecourt" surface combustion rights have been disposed of and the company, amalgamated with Messrs. Spencer, of Hitchin, is now devoting itself to the manufacture of boilers fired by gaseous or liquid fuel or using the waste heat from blast-furnaces, coke ovens, internal combustion engines, &c. Not a single feature of the old Bonecourt surface combustion boiler is to be found in the new designs. The new boilers for a time were still given the name of "Bonecourt," but to avoid confusion they are now known as "Kirke" boilers, after Mr. P. St. G. Kirke, who has had a very great deal to do with their design and development. It is claimed for the Kirke boilers that they give the same high efficiency as Professor Bone's surface combustion boiler without the use of refractory fire-brick packing in the tubes, an explosive mixture of clean rich gas and air and a draught of some 20in. of water.

The standard gas-fired Kirke boiler—to deal with it first—is suitable for coal gas, coke oven gas, blue water gas, producer gas or natural gas. A sectional view of a typical boiler of this description is given in Fig. 30. The boiler proper consists of a tubular shell without a fire-box, but containing a number of straight fire tubes extending from the smoke-box tube plate to the rear tube plate through which they emerge into the free air. At the inlet end is a gas burner or distributor—see Fig. 38, page 320—whereby each tube is separately fired by a gas jet. The necessary air is picked up by the gas at the mouth of the burner and not beforehand, while additional air to complete the combustion is drawn into the tubes by the draught which in the example illustrated is supplied by a motor-driven fan at the forward end. The gas jets can be controlled separately, by rows or as a whole. It is claimed that the length of the tubes relatively to their bore and to the draught is such that the gas is completely burned in the tubes with the admission along with it of not more than 10 per cent. excess of air above the quantity theoretically required, and that the products of combustion can be discharged at a temperature not more than 70 deg. Cent. above that of the water in the boiler. It is clear that the higher the draught the longer the boiler tubes have to be. A short gas-fired Kirke boiler for working with natural draught is illustrated in Fig. 31. In this instance, as shown at the Exhibition, the tubes are provided with spiral internal packings to baffle the hot gases.

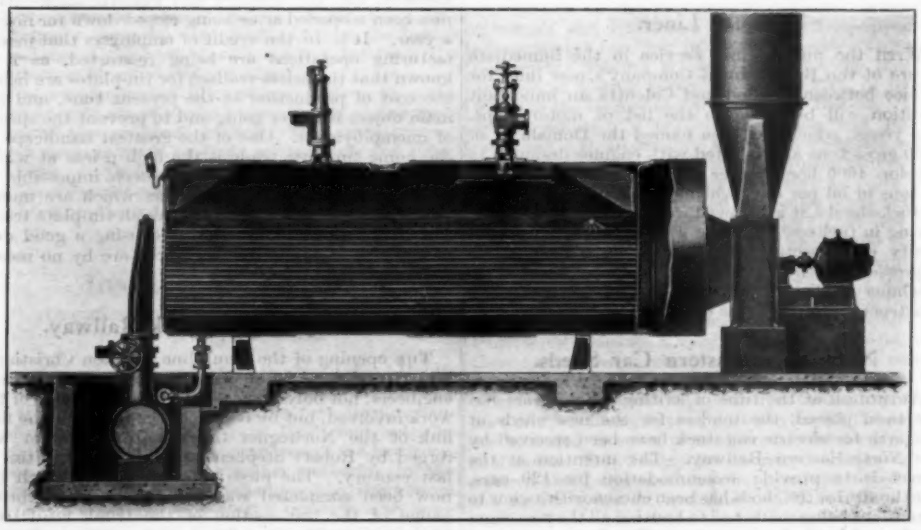


FIG. 30—STANDARD KIRKE GAS-FIRED BOILER

The Kirke boiler is made in a great variety of forms. Thus, to save floor space, a long gas-fired boiler for induced draught working may be divided into two equal sections placed one above the other with the steam and water spaces of the two parts in communication. In another gas-fired form the boiler shell is again split into two, the two parts being placed in line with a chamber containing a superheater interposed between them. The exact position of the superheater along the length of the boiler as a whole is determined by the degree of superheat required. For blast-furnace gas the boiler of the type shown in Fig. 30 is preceded by a brickwork combustion cham-

* No. II. appeared September 16th.

ber into which the gas is projected for ignition before passing into the tubes. The combustion chamber is provided with a grate and fire door to permit solid fuel to be used if required, to supplement the gaseous fuel. For utilising the waste heat remaining in the products of combustion discharged from industrial furnaces, internal combustion engines, &c., the boiler is again preceded by a brickwork chamber in which a superheater may be arranged. If the temperature of the waste gases is particularly high the inlet ends of the boiler tubes are protected by means of a ferrule of non-oxidisable metal, the tube end being belled out in such a way as to permit the bore through the

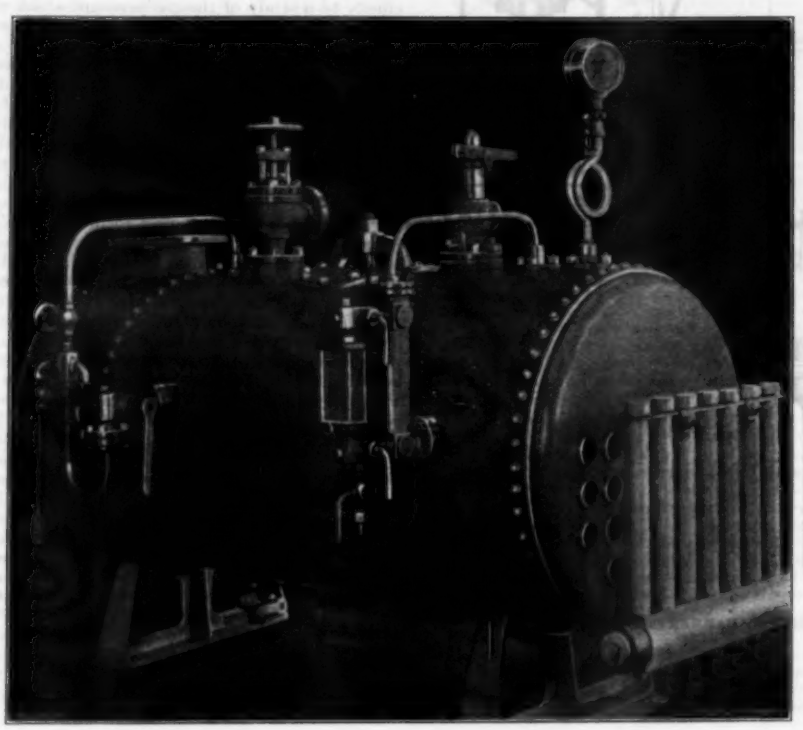


FIG. 31—KIRKE GAS-FIRED BOILER FOR NATURAL DRAUGHT

ferrule to be made equal to that of the original portion of the tube. In yet another type of Kirke boiler the central tubes are arranged to receive hot waste gases, while those on either side can be fired with gaseous combustible fuel. Finally, by a development of the waste heat boiler, a design suitable for burning oil fuel has been produced. This boiler consists of two portions with a superheater chamber arranged between if desired. The forward barrel portion is similar to that illustrated in Fig. 30. The rear barrel portion consists of a similar size of shell containing, in place of the tubes, one or more large combustion flues. The extreme rear end of this flue is lined with fire-brick, the heat retained in which atomises the oil introduced into the combustion chamber through a burner. The mixing and combustion of the air and atomised oil are completed in the unlined portion of the flue. Thereafter the sensible heat of the products is extracted in the superheater chamber—if supplied—and in the tubular portion of the boiler.

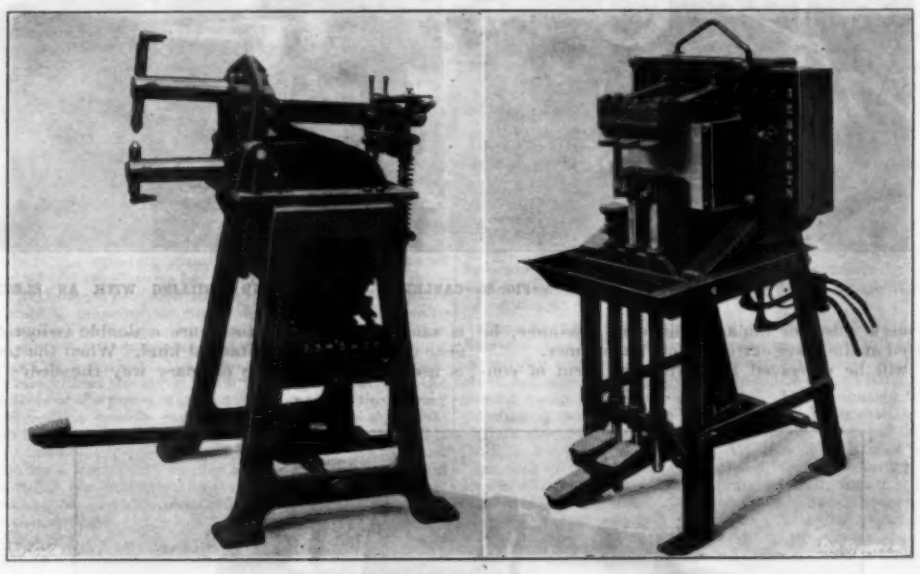
Among the many claims made for the Kirke boiler high efficiency is perhaps the chief. In this connection it may be said that a thermal efficiency of 91 per cent. is recorded in connection with a standard gas-fired boiler using induced draught, but without an economiser. The evaporation of this same boiler is given as 18 lb. from and at 212 deg. Fah. per square foot of heating surface. With a draught of 8in. of water the gases leaving the boiler had a temperature of 188 deg. Cent., the net calorific value of the gas being 480 B.Th.Us. per cubic foot. A Kirke oil-fired boiler without an economiser, using Mexican fuel oil of 18,550 B.Th.Us. calorific value per pound, showed an efficiency of 89 per cent., and evaporated 16.1 lb. from and at 212 deg. Fah. per square foot of heating surface. In this case the draught was 4in. of water and the temperature of the products of combustion 282 deg. Cent.

ELECTRIC WELDING.

Electric welding appliances of all descriptions are being exhibited by Buckley and Saunders. The most novel exhibit is the Cye arc welder, which was described in THE ENGINEER of July 1st. Various modifications of the original apparatus are shown, including a machine for rapid repetition work which can be attached to any standard drilling machine or bench. An interesting exhibit consists of a cast iron container into which a mild steel ring has been cast, and naval brass studs have been welded on to the latter for holding down the cover. An alternating pressure test up to 400 lb. per square inch had failed to reveal any sign of fracture, notwithstanding that the whole of the studs were welded on in eighteen minutes. Other exhibits of a similar character comprise ships' fittings fixed to a metal plate by means of welded studs, a radiator with the tubes welded to a mild steel plate, and various tubes and studs welded to sheets, bars, &c. Ferro-arc electrodes shown on the stand are claimed to give an efficient weld free from gas and slag incrustation. They are said to be easy to work with and to use a small amount of current. Experience is said to have shown that the metal deposited is free from oxidisation and porosity, has excellent tensile properties, and can easily be machined. Various other claims are made for these electrodes, such, for instance, excellent penetration with a minimum change in the nature of the surrounding metal. Bare wire electrodes are also manufactured for work that does not demand high tensile strength and which calls for low cost, such as filling in castings, &c. The single-operator arc welding motor generator shown in Fig. 39, page 320, is another of this firm's exhibits. The machine is designed on the opposed winding principle and is suitable for continuous working at full load. No external stabilising resistance or choking coil is necessary, for the machine automatically adapts itself to the varying loads. The motor and generator switch panels are mounted on the bedplate of the machine in the manner shown, thus making the set very compact. There is also an arc welding transformer suitable for connecting up to an alternating-current supply. By means of a small hand wheel currents of various strengths can be obtained to suit any thickness of plate or size of electrode. The apparatus is capable of giving an output of 300 ampères. It is mounted on wheels and a slinging arm is fitted at the top. Spot and butt welders and electric rivet heaters are shown. The former—see Fig. 32—is designed for continuous operation and is fitted with renewable blocks and electrodes and with water cooling arrangements. The heating speed can readily be adjusted by means of a plug which fits into receptacles connected to different transformer tappings. The spot welder illustrated is a 15-kilowatt machine and is designed for pressures of between 200 and 400 volts and for a periodicity of 25 or 50 cycles; but the transformer can, of course, be wound to other voltages and periodicities. When working on wrought iron or mild steel the machine will deal with metal up to $\frac{1}{4}$in. added thickness and brass up to $\frac{3}{32}$in. added thickness. For cutting off the current a trip switch is fitted, and immediately the weld is completed the current is switched off, thus enabling the operator to keep the pressure on the weld until it has cooled. Obviously this prevents any weakness of the weld arising in consequence of the metal springing. The arms of the machine are adjustable so that a direct pressure can always be applied to the weld. There is also a 30-kilowatt universal welder for spot, butt or press welding, a 6-kilowatt spot welder, and the electric rivet heater previously mentioned. The latter, which is shown in Fig. 33, is rated at 15 kilowatts and the transformer can be wound to suit any voltage or periodicity. The machine will accommodate rivets varying in length from $\frac{3}{4}$in. to 5in. without adjustment, and when using the three pairs of electrodes will heat rivets 5in. long and $\frac{3}{4}$in. in diameter. Rivets 1in. in diameter and 5in. long can be heated between any one of the three sets of electrodes. All the operator has to do is to depress the pedal and place the rivet between the electrodes and withdraw the rivet when it is hot enough. During the time the rivet is heating the operator places another rivet between another pair of electrodes, thus keeping the machine in constant operation. By means of a regulator different heating speeds can be obtained according to requirements, and, if necessary, rivets can remain in the machine at a dull red heat, but the heat can readily be increased as soon as the riveter is ready to commence operations.

FLEXIBLE PIPE JOINTS.

W. H. Dorman and Co., Limited, of Stafford, are exhibiting a large number of Flexstel pipe joints, one of which is shown in Fig. 40, p. 320. These joints have been devised with the object of taking the place, as far as is possible, of flexible hose pipe and take the form of a ball and socket joint. The socket is made in two pieces, with a circumferential joint, so that it may be taken apart for the insertion of the ball, and a sort of cup leather is used to seal the joint. These joints are being made in a large variety of sizes, from $\frac{1}{4}$in. bore upwards, and with flanged or screwed ends.



FIGS. 32 AND 33—BUCKLEY AND SAUNDERS' SPOT WELDING AND RIVET HEATING MACHINES

Some 5in. joints have recently been supplied to the Liverpool Corporation waterworks, and were tested to a pressure of 300 lb. per square inch.

A NEW ELECTRIC HAMMER.

An ingenious electric hammer, which is said to have met with the approval of some important American manufacturing firms, is shown on the stand of the Diamond Blower Company. The tool is claimed to be equal in every respect to a compressed air hammer and to be much more economical. Although the tool is designed primarily to act as a hammer, by the removal of the portion below the motor—see the left-hand drawing in Fig. 34—a drilling attachment can be fixed in position, when holes can be drilled up

to $^{9}/_{16}$in. in diameter, or the machine may be used for grinding. When the tool is operating as a hammer it strikes from 2000 to 4000 blows per minute. Obviously, the tool can be utilised for chipping or caulking and for the various other purposes for which compressed air hammers are employed, as shown in the illustrations given below in Fig. 35. The principle upon which the tool operates is extremely simple, as an inspection of the drawing Fig. 34 will readily show. The head A of the casing is constructed in the form of a handle having a grip switch B, which, when pressed by the operator, closes the contacts C. The manner in which the motor is mounted in the casing is shown clearly in the drawing and calls for no explanation. In common with all motors fitted to electric tools, the armature of the machine operating the tool under consideration is fitted with a fan for providing forced ventilation. At the lower end of the armature shaft is a small pinion which meshes with three spur wheels mounted on separate spindles which also carry smaller pinions which mesh with internal teeth on the sleeve E. The sleeve E therefore rotates on the thrust bearing F. At the lower part of the sleeve E is a double cam H, through the centre of which the reciprocating hammer L passes and which has laterally extending studs K which ride on the face of the cam and serve as the cam rotates to lift the hammer L against the action of a powerful spiral spring which surrounds the hammer as shown. When the studs K ride off the points of the cam the hammer is projected forward by the force of the spring and it delivers its blow. Where the hammer passes through the disc just below the thrust bearing F it has a square section, so that it cannot rotate. Any tool, such as a chisel or impact drill, can, of course, be inserted at the lower extremity of the hammer.

It will be perceived that with the form of construction described a high ratio gearing connection is provided between the motor and the cam. The construction of electric hammers, the makers explain, is not practicable unless a very small motor running at 5000 or 6000 revolutions per minute can be used, for otherwise the tool becomes too heavy, and in the past the design of suitable gearing has presented difficulty. With the design adopted, however, it is said to be possible to secure a double reduction gear of a solid and substantial kind. When the tool is used as a drill in the ordinary way the sleeve E is replaced by the sleeve O shown on the left of Fig. 34. This sleeve O is provided with a differently shaped casing S, in which a shaft T drives a drill chuck.

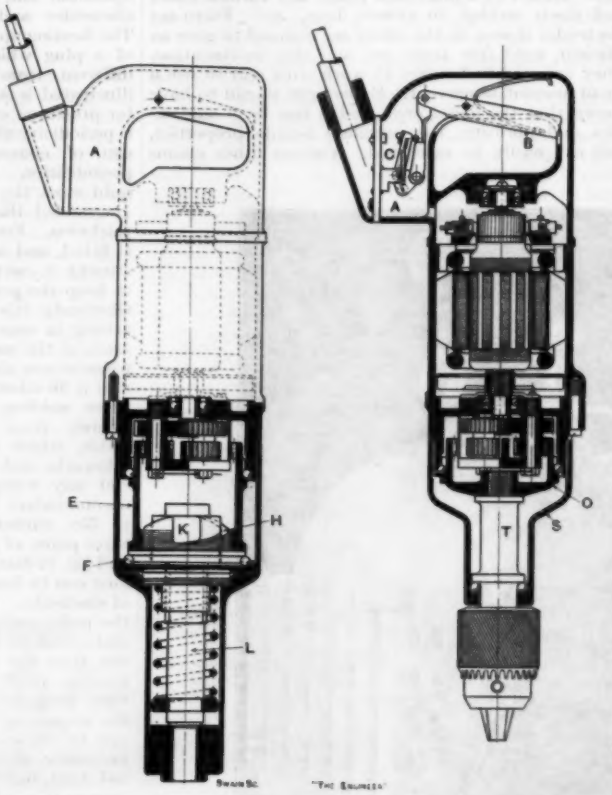


FIG. 34—ELECTRIC HAMMER AND DRILL

FIG. 35—CAULKING, RIVETING, AND DRILLING WITH AN ELECTRIC TOOL

FIG. 36—ELECTRIC HAMMER

Metal Cutting by Blowpipe.

Up in the gallery there is a machine, on the stand of the Godfrey Engineering Works, of Boundary-road, Westbury-avenue, Wood Green, London, N. 22, which will cut metal with the accuracy of a band saw, but at many times the speed of the saw, by means of an oxy-acetylene jet. Blowpipe cutting is, of course, a well-recognised process, but anyone who has only had experience of that class of cutting which an ordinary welder may carry out during his everyday work would be surprised at the fineness and accuracy of the cuts made by this machine. Mr. Godfrey, the inventor, informed us that he ascribed his success chiefly to a study of the gas pressure which was most effective, to the design of the blowpipe, and to the pre-heating of the oxygen. After a long series of experiments he found that it was best to work with a low gas pressure, so that there was no tendency for the molten oxide formed in the cut to be blown violently out, but rather that it should steadily trickle down as the cut progressed. With the usual form of blowpipe he found that the heating cone in the flame was so large that it inevitably melted the metal adjacent to the cut and formed the familiar ragged edges. So he devised a new form of jet, which imparted a whirling action to the mixed gases during their passage through the blowpipe, and reduced the length of the heating cone to about one-eighth of an inch. The result is that a clean, sharp-edged cut is made, which compares quite favourably as regards smoothness with that produced by a saw, and which may be reduced in width to less than one-sixteenth of an inch. Incidentally, says Mr. Godfrey, the ultra-violet rays produced by the flame have been greatly reduced, and although we cannot vouch for this fact, we found it noteworthy that the flame could be studied by the naked eye with far less distress than is the case with the ordinary blowpipe. The idea of pre-heating the supply of oxygen was evolved from the experience that the speed of cutting was far less in the autumn than it was in the heat of summer. An arrangement was thus interposed between the oxygen cylinder and the blowpipe—it can be seen on the left of Fig. 41, page 320—which raises the temperature of the oxygen to some 180 deg. Fah. The result is that the speed of cutting has been increased to such an extent that the horn plate seen standing against the machine in the illustrations, which measures 2ft. 4in. overall in each direction and is $\frac{1}{2}$in. thick, can be cut out of a plate, including the square opening, in 17$\frac{1}{2}$ min., a template being used as a guide.

Referring to the illustrations, it will be seen that the blow-pipe, which is partly covered by a hood, is fixed on a double-jointed swinging arm. This arm is formed by two deep aluminium girders, and all the joints are fitted with ball bearings, so that it takes the merest touch to move the blow-pipe.

There are two methods of feeding the blow-pipe along the cut. In one case the movement is controlled by a system of slides, while in the other the contour of a template is followed.

It will be noticed that the main frame of the machine somewhat resembles the housing of a planing machine. On to this housing there is pivoted a long slide, which, in turn, carries another slide at right angles. Both these slides have screw feeds. The carriage on the second slide also has a rotary movement, while the whole set of slides can be set at any angle with regard to the housing. A socket is provided on the rotary carriage for a peg at the top of the blow-pipe, which can thus be made to move in accordance with any of the feeds. Two friction-disc gearboxes give a wide range of feed speeds.

If a template is to be used, in cutting an intricate shape, it is fixed on the vertical spindle at the front of the machine, and the swinging arm is locked by a radius arm. A small roller is then put in the place of the peg at the top of the blow-pipe, and is kept in contact with the template by means of a spring. The work is fixed on the slotted table, and is rotated automatically as the cut advances.

Railway Matters.

DURING the month of June, the only commodity in which there was an increase in tonnage carried, when compared with the corresponding period of 1920, was "oils and inflammable liquids," which increased 32 per cent.

THE railway companies were able to effect an economy of 41.89 per cent. in their passenger train mileage during June as an off-set against the losses by the coal dispute. The number of passengers carried was only 27.22 per cent. less.

THERE has been no little trouble in Newfoundland over the railways, which, like the colony's steamers and other means of transport, are operated by the Reid family. After three days' debate the Legislature adopted a law by which the arrangement will be continued. The State will bear the loss of about 1,500,000 dols. yearly.

THE Osaka Hanshin Kyuko Electric Railway Company (the line between Osaka and Kobe, Japan) intends to construct an overhead line between Osaka and Juso, and also to double the present lines at an estimated cost of 3,000,000 yen. The company will also construct an underground railway from its Kobe terminus to Motomachi, at an estimated cost of 7,500,000 yen.

THE Skoda Works at Pilsen, Czecho-Slovakia, have now turned out the hundredth railway engine since the foundation of the republic three years ago. The monthly output is sixteen engines and tenders, while an equal number can be repaired. Roumania has so far been the best customer at the works, some 130 railway engines having been ordered, and partly delivered, on her account.

A SUMMARY of the report of the Committee presided over by Sir William Acworth, which, since last November, has been inquiring into the future of the Indian railways, has been published. The Committee is unanimously of the opinion that great changes are necessary, but is divided as to the State ownership of the lines. We believe that the report itself will shortly be available, and we intend then to discuss the question at greater length.

THE report of Colonel Pringle on the collision of August 8th at Selby, North-Eastern Railway, is a very brief document. As was anticipated, the responsibility for the collision is placed upon Deacon, the driver of the North-Eastern train from Bridlington to Leeds, who failed to observe that the signal applicable to the up platform line was at "danger" when he started his train and misread the up main line signal ("off" for the Great Northern express) as his own. The separation of the platform and main line signals is recommended.

A PASSENGER train was derailed at the St. Luke's station, Southport, of the Lancashire and Yorkshire company on the morning of Sunday, July 3rd. Only one passenger made any complaint. Permanent way men were at work at the time, and an experienced man actuated the mechanism connected to some facing points instead of that connected to the adjoining trailing points. The facing points were thus moved as the train was on them. As Major Hall said in his report on the accident, "it is difficult to suggest any practicable device which will provide definite security, however, against such irregular manipulation by a trained man."

UNDER the Railways Act the Conciliation Boards formed in 1907 and re-constituted in 1911 have ceased to exist. Of the fifty men who joined the Great Western board in August, 1912, only twenty were still serving when it expired. The majority of the thirty vacancies which had occurred were due to the men being promoted and to their removal to other districts. During these nine years 2851 cases were submitted by the secretaries of the men's side to the secretary of the company's side. Of these, 2247 were disposed of by agreement between the secretaries, 604 were discussed by the boards, and of these it was only necessary to submit 22 to the independent chairman.

RAILWAY servants in this country have, for thirty-five years or so, been permitted to have "privilege tickets" for themselves and their dependents, a benefit enjoyed also by superannuated and pensioned servants. These tickets cost one-quarter the ordinary fare. Now that the railway servants receive so much higher pay than formerly it has often been urged that the concession should be withdrawn. The Minister of Transport has, however, always replied that it was a concession of service and could not readily be taken away. Apparently, in Western Australia, the privilege ticket is not valued by the men; possibly the authorities have been using it as a set-off for part payment. Now, the Commissioners of the Western Australian Railways have proposed that the concession be abolished.

SOME interesting data as to locomotive capacity were given in the *Railway Gazette* of March 4th last, and in the issue of the 9th instant. The North British Company desires to obtain an improved type of locomotive in substitution of the 0–6–0 goods engine—which weighs, loaded without tender, 54 tons 14 cwt., and has a maximum axle load of 20 tons 6 cwt.—in order to get a better train load than the existing one of 27 loaded wagons for its mineral trains between the Fife coalfield and Aberdeen. The Great Western 2–8–0 engine weighs, loaded and without tender, 68 tons 6 cwt., and has a maximum axle load of 16 tons 7 cwt. The North-Eastern 0–8–0 three-cylinder weighs 71 tons 12 cwt. with a maximum axle load of 19 tons. The best stretch of North British line to gauge the capacity of a locomotive is the 6 miles 53 chains of 1 in 74½–1 in 75 on the up line between Bridge of Earn station—just south of the junction near Perth with the Caledonian Railway—and Glenfarg. The Great Western engine was tested on January 12th, but the result could not be completed owing to a heavy fall of snow. It succeeded, however, in taking 29 loaded wagons, weighing 550 tons, and two 20-ton brake vans over the length in 33 min.—the scheduled time. The coal dispute delayed the trial with the North-Eastern engine. It took place on August 28th under ideal weather conditions. There were three tests, and the results were:—(1) 617 tons 15 cwt. in 35½ min.; (2) 702 tons 19 cwt. in 30 min.; (3) 754 tons 16 cwt. in 33 min. The loads were exclusive of two 20-ton brakes.

Notes and Memoranda.

THE output of coal for the week ended August 27th was 4,102,300 tons, as compared with 4,327,800 tons in the previous week, and 4,590,600 tons in the week ended August 28th, 1920.

EINSTEIN'S theory of relativity is to be the subject of a cinematograph film which a German company has engaged some leading scientists to prepare for the autumn. By the use of diagrams and apparatus of various kinds the principles of the new theory will be made intelligible, it is said, to persons who are entirely incapable of understanding mathematical formulæ.

A RECENT issue of the *Zeitschrift des Vereines Deutscher Ingenieure* contains an article by Dr. Walter Reichel on high-tension transformers and converting plant. The author states that there are several 60,000 kilovolt-ampère transformers in operation in Germany, and that an increase in size of three-phase transformers to 75,000 kilovolt-ampères is possible.

ACCORDING to the *Canadian Engineer*, Mr. A. H. Coplan, managing director of the Hull Iron and Steel Foundries, Limited, Hull, Que., announces that he has perfected a method for the manufacture of Chromite, an alloy of steel, at a cost not exceeding that of cast iron. "Chromite," says Mr. Coplan, "has a much greater power of resisting the destructive effect of heat than has cast iron, and will therefore be largely used in the manufacture of fire-bars for locomotives, steamships, &c."

THE Home Secretary has drafted regulations relating to the manufacture and storage of celluloid and articles made of it, according to which stocks of celluloid must be kept in a special store outside the workrooms, and if more than 1 cwt. is stocked, the store room must be constructed of fireproof materials. Open lights and fires must not be used near celluloid, except to the extent necessary for manufacturing processes, and adequate means of extinguishing fire and of escape in case of fire must be provided.

A NEWLY incorporated company in Auckland, N.Z., has purchased an extensive freehold site in the centre of the city, on which it proposes to construct a new theatre, costing, with the site, £90,000. A feature of the building will be an escalator, while a proposal to make the shops to be incorporated in the front of the theatre "disappearing" is receiving the serious consideration of the promoters. It has been suggested that the shops could be lowered into a well each night by means of lifts, thus making the shop roofs a portion of the floor of the theatre vestibule.

ACCORDING to a Reuter dispatch, the American General Electric Company reports that on September 13th it transmitted current from a transformer at a pressure of over a million volts, and at the ordinary periodicity of 60 cycles per second. The physical laws appertaining to the behaviour of high voltages were found to hold good at this enormous pressure, and it was found possible to transmit the current without prohibitive loss. The test has confirmed the belief that it is possible to use much higher transmission voltages than those that have been adopted hitherto, and points to the possibility of transmitting power over great distances.

SOME interesting figures are given in the September issue of the *Motor Ship* relating to the expenditure of fuel on the maiden voyages of one of the most up-to-date geared turbine steamers with oil-fired boilers, belonging to the United States Shipping Board and a recently constructed motor vessel. The voyages over which the comparisons were made totalled about 25,000 miles, and it was found that whereas the motor ship carried 13,000 tons of cargo at a speed of over 11 knots, against 11,500 tons and 9¼ knots for the steamer, the fuel bill of the former amounted to about £73 per day against £113 per day for the smaller and slower steamer. The United States Shipping Board afterwards converted the steamer to turbo-electric drive, but it was then found that the economy of the motor ship was still more marked, as the fuel for the steamer thus equipped averaged £123 daily.

IT is reported that one of the tool-making firms has been constructing grinding heads for small internal grinding, in which the grinding spindle is required to revolve at about 45,000 revolutions per minute. One of these grinding attachments has been tested in the National Physical Laboratory in order to show that this speed is really obtained. The drive is by means of a stretched rubber band, and at speeds of about 20,000 to 30,000 revolutions it shows negative slip; that is to say, the grinding spindle runs faster than the speed given by the ratio between the diameters of the pulley wheels and the speed of the driving spindle. The spindle ran quite satisfactorily at 45,000 revolutions per minute, and even at this speed showed a slip of but one-sixth per cent. The makers have expressed a wish for a test upon a similar spindle running at 100,000 revolutions per minute, and it will probably be undertaken as soon as a suitable method of measuring the speed has been devised.

THE discovery by Mr. A. L. Marsh, in 1905, of the remarkable properties possessed by alloys of nickel and chromium, has had a far-reaching effect upon the electrical heating and cooking industry. It has almost revolutionised it. Prior to that time, electric heating elements were unreliable, could be operated at only a low temperature, the dissipation of energy represented by the watts consumed per square inch of heated surface was small, and under the best conditions the elements possessed only a short life. The modern electric heating element possesses none of these disadvantages, and its present satisfactory state of development is directly attributable to the production of nickel-chromium alloys. The actual manufacture of nickel-chromium alloys is among the most difficult problems in metallurgy. Both metals melt only at very high temperatures, and the problem is further complicated by the fact that at its melting point chromium is readily oxidised and nickel is a solvent for carbon. The slightest variation in the process of manufacture is apt to affect results at some later stage, hence the most careful control must be exercised at all times. The alloys are commonly made in the form of rods of about ¼in. diameter, and the process of reducing the rods to the sizes of wire and strip commonly used occupies about four months.

Miscellanea.

THE Electrolytic Zinc Company of Australasia, Limited, is reported to have completed a contract with the British Board of Trade for the sale of 750,000 tons of concentrates and slimes.

IN order to stimulate business, the Reading Iron Company, Pa., has reduced the selling price of all kinds of pipe by from 10 dols. to 12 dols. a ton, to take effect at once. This is the fourth reduction made this year.

REPORT of a special commission in charge of the investigation of coal deposits in Turkestan estimates the quantity of coal at 25 billion poods. There are said to be 700 separate coal deposits, some of which can be easily worked. The average thickness of the deposits is 17ft.

A GREAT sewage system is projected by the Kobe municipality, Japan, at an estimated cost of 40,000,000 yen (nominally £4,000,000). The proposed conduit will be about 5 miles in length, from 12ft. to 15ft. in diameter, and laid 18ft. to 30ft. below the surface of ground.

AN exhibition of foundry machinery, organised by the Province of Liége Technical Association of Founders, is being held in the Jardin d'Acclimatation at Liége, and will remain open until October 3rd. A congress of founders will also be held during the period the exhibition is open.

IT is stated that the Canadian Department of Naval Affairs has in view the installation of a very powerful continuous wave system wireless station near Vancouver to undertake land work and to communicate with distant points up the coast, thus leaving the present station at Point Grey to handle shipping business only.

ACCORDING to an article in the *Journal* of the British Chamber of Commerce at Shanghai, living in China may cost at the present time from about £46 to £68 per month for a batchelor, according to whether he stays in a boarding-house or hotel in Shanghai. In Hong Kong the cost is practically the same, but in Tientsin the corresponding figures are some £43 and £49 respectively.

FROM particulars received concerning the Welsh National Exhibition, which is to be held at Cardiff next year, we learn that the British exhibits will be housed in a hall, the floor space of which will be 172,800 square feet—"the largest individual hall erected in an exhibition." The site of the Exhibition will be the fields adjoining the Sophia Gardens and close beside the grounds of Cardiff Castle. All branches of engineering and mining will be included.

THE Quest has been fitted by the Marconi Company with a very workmanlike wireless equipment, including three wireless telephone sets, one for use on board, an aeroplane set, and a set to be taken on shore or on the ice by landing parties. Even the aeroplane set has a range of 80 miles, that on the vessel being slightly more powerful. The latter is expected to work in the Antarctic, where there is practically no interruption from atmospherics, up to 200 miles. Yet it is contained in a cabinet only 28in. long, 15½in. high and 9in. deep, and only requires a power of 100 watts.

ON July 22nd, 1919, the Czecho-Slovak National Assembly passed an Electricity Bill, the purpose of which is the systematic utilisation of water power and the electrification of the country, with the financial assistance of the State. The electrical industries in Czecho-Slovakia are considerable, and especially in recent years the shortage of coal and petroleum has caused a large increase in the employment of electricity, both for lighting and domestic services. This demand for current is met by 345 public electrical supplies, while, in addition, a considerable number of power stations supply private needs.

ACCORDING to the *Iron and Coal Trades Review*, at the present time there are only two borings for oil being carried on by the Government through its petroleum managers. The two wells upon which drilling is proceeding at the present time are those at Werrington, North Staffs, and D'Arcy in Scotland. The several wells in Derbyshire which failed to yield oil are about to be plugged, while the Staffordshire boring at Apedale is also abandoned. At the West Calder well, in Scotland, boring has for some time been suspended, the well being already over 4000ft. deep. It is expected, however, that this test will be continued.

JUGO-SLAVIA, the kingdom of the Serbs, Croats and Slovenes, has to import from abroad machinery, all kinds of railway material, scientific instruments, brass, copper, steel, &c., amongst other goods, which the United Kingdom should be in a position to supply. Unfortunately, the purchasing power of the new kingdom is limited, and though gradually recovering, must remain restricted until its resources are developed. To this end, states the *Electrical Review*, capital is needed, transport must be improved, and labour requires to be reorganised. By co-operating in these directions with local interests, British organisers would be making a useful contribution towards the reconstruction of a promising region, and might at the same time gain an outlet for British goods.

AN article in the *Berliner Tageblatt*, dealing with the increasing activity in Russo-German trade, states that the Soviet Government recently ordered 700 railway engines, which German manufacturers have undertaken to deliver in six to seven months. The first cargo of six engines is already at Hamburg awaiting transport to Russia. The Soviet Government has also placed orders in Germany for chemicals, agricultural machinery and rails to the value of a milliard and a-half marks. The first deliveries of goods from Russia have already arrived in Germany. Twelve wagon-loads of Russian skins will be sold by auction at Leipzig within a few weeks. Three steamer loads of building timber have already been sold, also large quantities of hemp and flax. A steamer with a cargo of 1000 tons of asbestos is expected. The Soviet Government, the German newspaper learns from authoritative quarters, attaches great value to trade relations with Germany, and has exported to no other country to a similar extent. Various German firms and groups have recently made a number of proposals to the Soviet authorities concerning the acquisition of concessions and the provision of credits.

THE SHIPPING AND ENGINEERING EXHIBITION AT OLYMPIA

(*For description see page* 316)

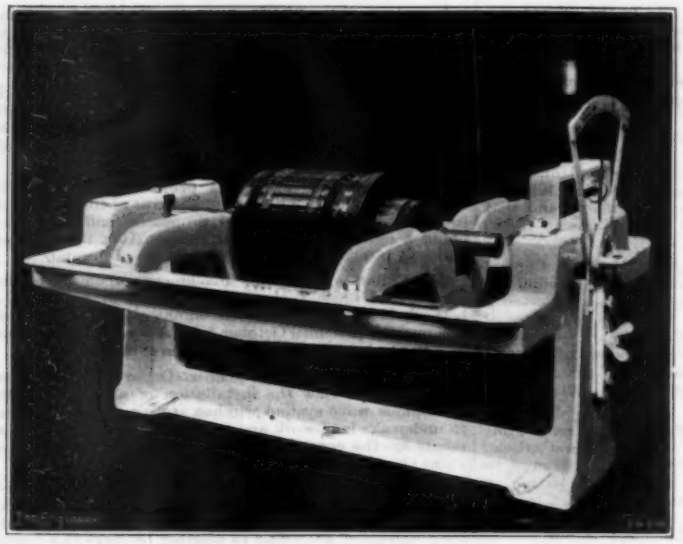


FIG. 37—AVERY STATIC BALANCING MACHINE

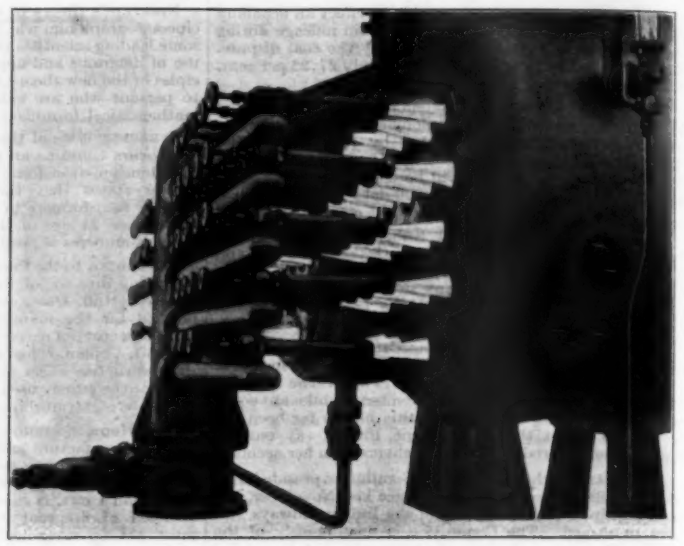


FIG. 38—GAS BURNERS OF KIRKE BOILER

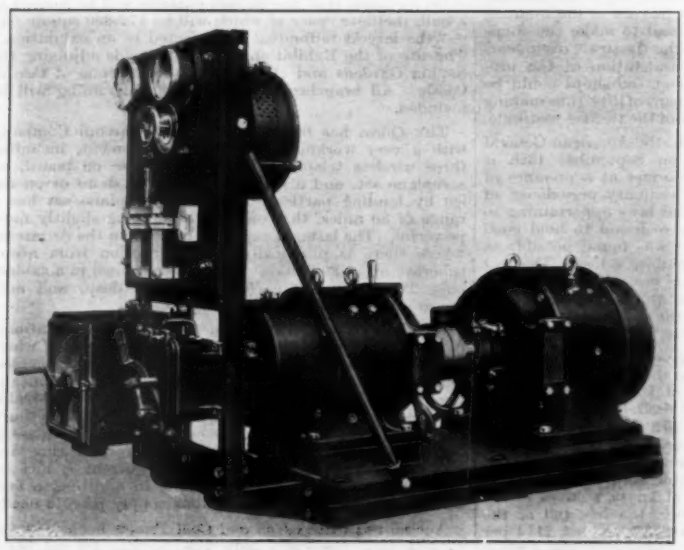
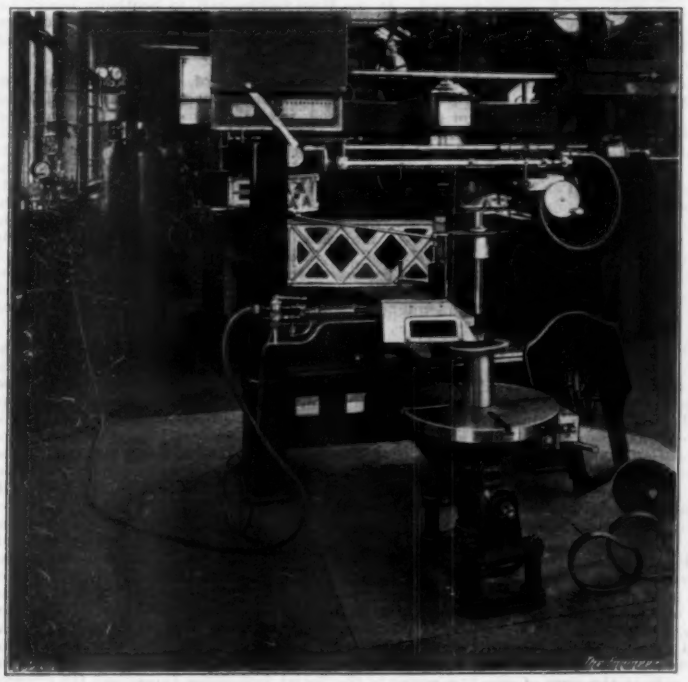


FIG. 39—BUCKLEY AND SAUNDERS' ARC WELDING SET

FIG. 40—DORMAN'S FLEXSTEL PIPE JOINT



FIGS. 41 AND 42—GODFREY AUTOMATIC OXY-ACETYLENE CUTTING MACHINE

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By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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TWO-PAGE SUPPLEMENT—111IN.–123IN. SLIDING, SURFACING AND SCREW-CUTTING LATHE.

DEATH.

ON September 14th, suddenly, in London, HERBERT FRANCIS ACOCKS, A.M. Inst. C.E., of "Fernyhurst," Ashtead, Surrey, aged 59.

THE ENGINEER.

SEPTEMBER 23, 1921.

The Gas Turbine.

THE practical and scientific difficulties which undoubtedly beset the path of the would-be designer of an internal combustion turbine are apparently still proving insoluble. A number of independent investigators, both at home and abroad, have for some time past been concentrating on attempts to discover a solution of a problem which certainly embraces more genuine difficulties of a mechanical nature than were ever provided by the steam turbine or the internal combustion engine, while the thermodynamic considerations involved are in a class entirely by themselves. Baffling as the production of a satisfactory design would seem to be at present, it is difficult to avoid the feeling that a solution might be afforded by some stroke of genius or luck at almost any moment; but it has resisted such strenuous and frequent attack during the last quarter of a century with such success that the probability of an early realisation of an efficient internal combustion rotary engine seems to be rather on the wane than otherwise, and some at least of those who have gone very deeply into the matter during the last two or three years are reluctantly abandoning their efforts. Experience of the steam turbine has taught a great deal that is of value in approaching the internal combustion turbine, particularly in the direction of its limitations. Similarly, experience with petrol or large Diesel engines has indicated where difficulties are apt to arise in using other forms of energy. But in attacking a problem such as that of a gas combustion turbine, it is absolutely impracticable to be bound down by any conventional ideas in regard to design beyond the fundamental thermal consideration of heat received minus that rejected, in its ratio to that received, which applies alike to all heat engines.

To obtain combustion energy in a utilisable form, whether for expanding through a nozzle and yielding up kinetic energy in a jet, or whether the static expansion force behind a piston is to be used as in a Diesel engine, compression is required, and here the mechanical difficulties at once begin. Good results can be obtained with rotary air compressors only up to comparatively low pressures; 100 lb. per square inch is about the limit yet obtained, and it involves the use of a large number of fans in series. We know that if it were possible to solve the problems at the high-pressure end of the gas turbine we could utilise a considerably lower exhaust temperature than is possible in a Diesel engine, just as one can efficiently use lower vacua in steam turbines than in low-pressure cylinders; and, consequently, to attain the same thermal efficiency the initial pressure and temperature need not be so high, but the compression will require to be of an order quite unattainable with rotary compressors. Hitherto, in all the gas turbines tried, this negative work of compression has practically nullified the positive work of the turbine itself, and in cases in which the compression has been provided externally the power required has usually even exceeded the turbine output. Another objection to direct-driven rotary compressors lies in the necessity of meeting the conditions of starting up or of altering the revolutions of the main turbine. At the cost of adding to the negative work in friction a reciprocating compressor will be essential to overcome this difficulty. The turbine will require to be operated on a continuous combustion system, as no fluctuation of rotary speed even as small as that found in the Diesel engine will be satisfactory. By splitting the power up into eight cylinders the volume of oil introduced into each on every alternate stroke is reduced to a very small quantity, and though at 120 revolutions the working stroke occupies but one-quarter of a second, the problem of dissipating the heat absorbed by the metal of the cylinder and particularly by the cylinder cover is a formidable one, and quite as much of thermal energy in the fuel as is converted into work goes overboard in the cooling water. This cooling is continuous, and yet the explosion stroke only occupies one-quarter of the time. How is a combustion chamber that is to be subjected to continuous heat likely to fare? Here we come across the germs of a wide series of problems relating to metals under the influence of heat. A boiler furnace stands up to 2500 deg. Fah. for years on end without difficulty, but its function is to transmit the heat as fast as it can; but the function of the turbine material is to withstand pressure and not to pass more than is absolutely necessary to avoid rupture due to expansion strains. It is possible to keep this combustion small by subdividing the amount of fuel supplied over a number of separate chambers, and further over a number of turbine wheels in parallel, and by arranging the firing so that a time element is introduced to assist in the heat transmission from each chamber. No scheme that offers itself seems able to meet the double requirement of adequately cooling the combustion chamber and of reducing the existing loss of heat carried away in the process. The next difficulty which requires to be circumvented —space forbids the mention of more than a few— lies in the fact that the efflux velocity of high-pressure and high-temperature gas expanding to a lower pressure is very considerable. There has been a general tendency in steam work to reduce velocity through nozzles to a point, where possible, below the critical value so that the use of divergent nozzles is obviated. This is practically impossible in internal combustion work, and the uncertainty of the proper proportions to provide for the nozzles is a further source of inefficiency, though the real objection lies in the difficulty of suitably harmonising wheel speed and jet speed when the latter is high. Actual high speed of revolution is immaterial; gearing corrects that. But it is quite impossible to exceed certain peripheral speeds depending on the form of wheel and blade attachment, and *with stiff shafts* a limit in the neighbourhood of 500ft. per second is involved. For maximum efficiency and a single row of blades this limits the gas speed to far below its actual value; velocity compounding must therefore be resorted to, and even then a sacrifice will be made. Thus we find that the fundamental condition on which efficiency depends—that is, on the transference of the kinetic energy to the turbine wheel—is, step by step, being reduced to a position in which the quantity of energy transferred minus the negative work expended in compression will not reach the standard of thermal efficiency obtained in the reciprocating unit. The largest gas turbine unit so far constructed has, we believe, not attained more than about a quarter of its designed 1000-kilowatt output. The early efforts of Armengaud and Lemale in France and of Holzwarth in Germany did little else than indicate the wide extent of the difficulties involved in dealing with a fluid other than steam or water in rotary engines. Quite a number of experiments have been conducted in this country and in Germany, but in all cases the negative work of compression has proved to be the stumbling block. This fact in itself indicates the attainmentof a very low turbine efficiency, because the work of driving the air compressor for a big Diesel engine for charging purposes is only of the order of about 5 per cent. of the full power, and, from a consideration of the other losses, that absorbed on the compression stroke cannot be very great. We have not in the foregoing sketch of the pure gas turbine referred to mixed combustion turbines. The possibilities of water injection into the combustion chamber, with the double object of reducing its

temperature, and in doing so utilising the potential energy thus transferred in the fluid impinging on the wheel instead of letting it flow uselessly away in the cooling water, have not been overlooked, nor has the use of the exhaust gases, somewhat on the lines of the Still engine, been ignored. In lieu of using them to raise steam, it has been proposed to pass them through a turbine, but the fallacy of the idea soon becomes apparent on investigation. The injection method, however, offers several possibilities that the pure combustion turbine does not, and it is along these lines that some development may be eventually expected.

The complete solution of the problem would be a step of the most profound importance in engineering. The fact that inside one large cylindrical casing it would be possible to transmute the thermal value of the liquid fuel in the bunkers into brake horse-power on the shaft without the mass of separate intermediate parts which constitute the existing engine would have an extraordinarily far-reaching effect on every branch of manufacture and power supply. Ideal as the suggestion may be, or nebulous as the prospects of its realisation seem to be at present, the introduction of a motor which dispensed with steam generating and condensing plants and was applicable in all sizes from motor cars to mammoth liners would create a veritable upheaval in all sections of industry. We really wonder how many firms which would be very intimately affected by such an occurrence have carefully considered what their position would be in the event of such a motor being forthcoming without much warning. That it would entirely supersede the use of steam machinery is most unlikely, but for the larger and more important power plants and steamships no motor could offer a more ideal form of prime mover. Pleasant as it may be to speculate on the presence of such perfection, the difficulties in the way of its attainment have hitherto proved too formidable. They are not, however, provably impossible in theory, and consequently it is within the bounds of possibility that such a motor may be forthcoming, and, if so, it is not unlikely to take a number of people by surprise.

Steel—Hot and Cold.

A PAPER presented to the Iron and Steel Institute at its recent meeting in Paris by M. Dupuy reminds us that, after all, our knowledge of the properties of steel, and still more of other engineering materials, at high and at low temperatures is still somewhat fragmentary. The figures obtained by M. Dupuy for the tensile properties of steel at temperatures ranging up to and beyond a red heat do not appear to be in entire agreement with those secured by Rosenhain and Humfrey some time ago, and the discrepancy remains to be explained by further investigations, since the data of the earlier workers are known to have been obtained by experiments carried out with the greatest care and accuracy and with experimental refinements which have not been attempted by Dupuy. The latter, however, worked with test pieces of approximately normal dimensions, and his results may therefore appeal more directly to engineers, who will leave their correlation with metallurgical theory to the consideration of experts.

The engineer, however, is not so much interested in the tensile properties of steel at temperatures in the neighbourhood of the critical points, as in the influence which rather smaller rises of temperature are likely to produce. This interest is, or should be, steadily increasing, since the range of temperatures which occur in engineering practice is steadily and even rapidly widening. In the use of superheated steam, turbine engineers at quite an early stage encountered difficulties arising from the action of such steam on the cast iron which was then used for turbine casings. While that particular difficulty was soon overcome, the action of high-temperature steam on steel and other materials is still a matter of anxiety to the turbine designer, mainly in regard to the material of blading. Research aimed at the direct solution of that somewhat special problem is, we believe, being vigorously pursued by those interested, but what is really required is a wide and general extension of our knowledge of the high-temperature properties of our materials generally. Nor can we regard the temperatures attained by superheated steam as being in any sense near the higher limit of temperature which must be considered. In the internal combustion engine in its many forms, this question of the properties of materials when hot has already become a matter of primary importance, and the range of temperatures involved is continually widening. Every step forward in the thermodynamic efficiency of our engines tends to involve the employment of higher temperatures, and those who have considered the problem closely will agree that one of the main difficulties in the way of the practical realisation of the internal combustion turbine resides in finding materials which will allow of the development of high pressures at very high temperatures. For the purposes of such problems as these, however, much more is required than a mere knowledge of the tensile properties of the material, including "yield point" and ultimate stress. Not only do we need a knowledge of the shock-resisting properties of our materials, but also—and much more vitally—do we require to know their power of enduring alternating stresses or "fatigue." The great forward stride in the development of methods of testing fatigue which was described in the paper by Mr. Gough, of the National Physical Laboratory, recently published in our columns—THE ENGINEER, August 12th last—justifies the hope that the quick and accurate determination of fatigue-resisting properties at high temperatures may soon become a comparatively easy matter. It is certainly knowledge which the engineer should welcome and utilise. There is, however, another branch of the knowledge of materials at high temperatures in which we are as yet but imperfectly equipped. We refer to such matters as the brittleness of steel under certain conditions at what is known as a "blue" heat. While a good deal of investigation has been devoted to this question, it still remains surrounded with a considerable degree of mystery. Metallurgists have not yet given us any satisfactory explanation of this brittleness, and we are not even sure that it exists in all steels, nor do we know with real certainty the range of temperature which is dangerous. We have recently seen the results of a long series of notched-bar impact tests at high temperatures, which suggest that the impact figure may in some cases increase with surprising rapidity with rising temperature, afterwards declining again; while in other steels this rise is insignificant. Such phenomena suggest that in those regions of temperature lying between the ordinary temperature and that at which steel is usually forged and rolled there is a wide field for advance in a direction which will not only serve to widen our knowledge of steel, but will furnish data which are either required immediately by the engineer or are likely to be needed by him in the near future.

Unhappily, at the present moment the cold winds of industrial depression and of governmental economy alike tend to wither the buds and even the roots of research, so that the demands for new knowledge are liable to meet with the response "no funds available." Yet it must be borne in mind that it is by the research work of to-day teat we lay the foundations of future prosperity. We began by referring to a paper read before the Iron and Steel Institute—a paper whose value we appreciate. But cannot that Institute do more than devote an hour to the discussion of such a subject? It might surely be expected of a great Institute, representing the greatest of our industries, that it should be in a position to encourage and even to carry out research. We believe that the Institute did, a few years ago, appoint some research committees, but what research have they produced or stimulated? The field which we have indicated, in which further knowledge is urgently needed, is but one example. The other extreme of the temperature range—extreme cold—is another, and a long list could be easily drawn up. But the influence of temperature on the primary properties of our materials is such a striking example of our urgent need for more knowledge, that no longer list could strengthen the case. It should not be a question of whether we can afford to do such research, but rather a realisation that we cannot afford to do without it.

Boiler Efficiency and Output as Affected by Draught.

By Professor ALEXANDER R. HORNE.

THE purpose of this article is to investigate the relations between the efficiency, evaporative power and stokehold air pressure in the steam boiler, in the light of the results of a series of twelve exhaustive tests which were carried out by five authorities upon a marine boiler of the "Inglis" type; and, where possible, to compare the general conclusions arrived at with those given by other investigators. The outstanding feature of these tests was the high efficiency obtained, even with high air pressures.

The Inglis boiler is of the cylindrical, single-ended, wet-backed marine type, but of special design. There are three furnace tubes, from each of which the gases find their way into a common combustion chamber at the back of the boiler. The gases then return to the front of the boiler through a cylindrical flue, and pass into a second, water-jacketed, combustion chamber. From this chamber they flow through a large number of tubes to the back of the boiler.

The principal dimensions of the boiler tested were—

Diameter of shell	14ft.
Length of shell	11ft.
Diameter of furnaces, three	3ft. 4in.
Diameter of return flue, one	3ft. 4in.
Diameter of tubes, (309)	2¼in.
Heating surface	2620 sq. feet
Grate area	55 sq. feet
Working pressure	180 lb. per sq. inch

The boiler was erected in an air-tight housing, which formed a closed stokehold. The air pressure was maintained constant during each test, and varied in the series between 0.4in. and 3.0in. of water. Analyses of the waste gases were made in all the tests.

A summary of the results of the tests are given in the table on page 323.

Relation between Air Pressure in Stokehold and Coal Burned per Square Foot of Grate Surface per Hour.—Coal per square foot of grate per hour is plotted against stokehold air pressure in Fig. 1, p. 323. The points are found to correspond closely to the law—

Coal per square foot of grate per hour

$$= 27.8 \sqrt{\text{air pressure}}, \text{ or}$$

$$C = 27.8 \sqrt{P} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

This relation is shown by the curve in Fig. 1.

Bertin and Robertson state* that it is the practice at Indret to use the formula—

$$P = 0.00095\, C^2$$

in the design of marine boilers for the French Navy. This can be written—

$$C = 32.5 \sqrt{P},$$

which is of the same form as (1).

It therefore appears that the relation between C and P can be expressed in the form—

$$C = k \sqrt{P} \quad . \quad . \quad . \quad . \quad (2)$$

where k is a constant for any one boiler.

Relation between Efficiency and Coal per Square Foot of Grate per Hour.—Rankine† states that—

$$E = \frac{a\,S}{S + b\,F} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where E = efficiency; S = heating surface in square feet; F = total coal burned per hour in pounds; and a and b are constants.

$$\text{If } G = \text{grate area, } R = \frac{\text{heating surface}}{\text{grate area}} = \frac{S}{G}, \text{ and}$$

C = coal per square foot of grate per hour—

$$F = {}^{1}C\,G = C\,\frac{S}{R},$$

and (3) reduces to—

$$E = \frac{a}{1 + \frac{b}{R}C} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$= \frac{a}{1 + d\,C} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where d is a constant for any one boiler.

Mr. Lawford H. Fry‡ has used a formula of this type, in which he introduces a factor with $d\,C$ to allow for variations in the calorific value of the coal used. He states that Professor Goss has made much use of such a formula in connection with tests of locomotive boilers.

The tests of the Inglis boiler—see Fig. 2—suggest that in (4)—

$$a = 0.95,\ b = 0.213.$$

The mean value of R for this boiler, as given by the several experimenters, is 47.4, which gives, in (5)

$$d = 0.0045.$$

Rankine§ suggests for boilers fitted with forced draught—

$$a = 0.95,\ b = 0.3.$$

Mr. Fry‡ states that for the locomotive boilers tested—

$$a = 0.89,\ b = 0.408 \text{ to } 0.595.$$

The relatively low values of b in the case of the Inglis boiler is due to the fact that the efficiency is so well maintained at high air pressures.

Relation between Efficiency and Air Pressure.—By substituting for C in (5) the value given in (1)—

$$E = \frac{a}{1 + d\,k\,\sqrt{P}}$$

$$= \frac{a}{1 + m\,\sqrt{P}} \quad . \quad . \quad . \quad (6)$$

where m is a constant.

For the Inglis boiler—

$$E = \frac{0.95}{1 + 0.125\,\sqrt{P}} \quad . \quad . \quad . \quad (7)$$

This law is shown by the curve in Fig. 3. The points indicate the results of the tests.

Relation between Equivalent Evaporation, Rate of Coal Consumption and Air Pressure.—If H be the

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* "Marine Boilers," by Bertin and Robertson. Second edition. Page 75.

† "The Steam Engine," Rankine. Thirteenth edition. Page 293.

‡ "Combustion and Heat Balances in Locomotives." "Proceedings," I. Mech. E., 1908. Pages 279–284.

calorific value of the fuel, in B.Th.U. per pound, the theoretical evaporation in pounds of water from and at 212 deg. Fah. is $\frac{H}{966}$; and if W be the actual equivalent evaporation per square foot of grate in pounds per hour, obviously—

$$W = \frac{H}{966} \times \text{coal per square foot of grate per hour} \times \text{efficiency} = \frac{H}{966} . C E \quad . \quad . \quad . \quad . \quad (8)$$

Substituting the value of E from (5)—

$$W = \frac{a H C}{966 (1 + d C)} \quad . \quad . \quad . \quad (9)$$

Straight-line Formulæ.—It will be observed from Fig. 3 that the curves of efficiency and evaporation are approximately straight. Taking the straight lines which agree most closely with the curves, within the range of 15 lb. and 50 lb. of coal per square foot of grate per hour, it is found that—

$$E = 0.94 - 0.033 C \quad . \quad . \quad . \quad (13)$$

and $$W = 50 + 10.3 C \quad . \quad . \quad . \quad . \quad (14)$$

D. K. Clark‖ expresses the relation between W and C in the form—

$$W = p R^2 + q C,$$

where p and q are constants for any one type of boiler, and R is the ratio of heating surface to grate area, as before.

Test Results from Inglis Boiler.

Authority.	Air pressure, inches of water.	Calorific value of coal, B.Th.U. per lb.	Coal per sq. ft. of grate, lb. per hour.	Equivalent evaporation, lb. per hour.			Efficiency, per cent.
				Per lb. of coal.		Per sq. ft. of grate.	
				Actual.	Coal at 14,000 B.Th.U. per lb.		
B.	0.4	14,080	20.1	12.70	12.62	252	87.58
D.	0.4	13,864	16.2	12.87	12.98	210	89.5
D.	0.4	13,864	19.0	12.70	12.82	244	88.4
E.	0.49	13,952	19.2	12.45	12.50	240	86.21
A.	0.51	14,350	19.82	12.97	12.64	250	87.34
A.	0.99	14,280	27.31	12.24	12.01	328	82.8
D.	1.00	13,864	29.0	12.08	12.20	354	84.1
B.	1.5	14,080	33.2	11.82	11.78	391	81.32
C.	2.0	13,647	38.7	12.02	12.33	477	85.0
A.	2.87	13,890	48.89	11.33	11.44	560	78.8
B.	3.0	13,600	48.0	10.94	11.28	541	77.82
C.	3.0	13,647	48.9	11.34	11.63	569	80.2

Authorities.—A. Messrs Burstall and Monkhouse. B. Professor R. Stanfield, M. Inst. C.E. C. Messrs. John Brown and Co., Limited. D. Messrs. Denny and Co. E. The Fairfield Engineering and Shipbuilding Company.

Taking H = 14,000, and using the values of a and d already found for the Inglis boiler—

$$W = \frac{3060 C}{222.2 + C} \quad . \quad . \quad . \quad . \quad (10)$$

Again, replacing C and E in (8) by the values given in (1) and (6)—

$$W = \frac{k a}{966} . H . \frac{\sqrt{P}}{1 + m \sqrt{P}} \quad . \quad . \quad (11)$$

For the Inglis boiler, taking H = 14,000—

$$W = \frac{382 \sqrt{r}}{1 + 0.125 \sqrt{P}} \quad . \quad . \quad . \quad (12)$$

The values of W given by (10) and (12) are shown by the curves in Figs. 2 and 3 respectively. The plotted points are the actual equivalent evaporations, corrected by proportion to a common basis of coal having a calorific value of 14,000 B.Th.U. per pound, and are taken from the table above.

The results can be summarised as follows :—

$$C = k \sqrt{P}$$

$$E = \frac{a}{1 + d C} = \frac{a}{1 + m \sqrt{P}}$$

$$W = \frac{a H C}{966 (1 + d C)} = \frac{k a}{966} . H . \frac{\sqrt{P}}{1 + m \sqrt{P}}$$

where—

C = Coal per square foot of grate in pounds per hour.
P = Air pressure in stokehold in inches of water.
H = Calorific value of coal in B.Th.U. per pound.
E = Efficiency of boiler.
W = Equivalent evaporation from and at 212 deg. Fah. in pounds per square foot of grate ;

and a, d, k and m are constants, and $m = d k$.

In the case of the Inglis boiler, $a = 0.95$, $d = 0.0045$, $k = 27.8$, $m = 0.125$.

Referring to these latter figures, the higher values of p and the lower values of q, when compared with the former constants, are in a measure due to the higher rates of combustion in the latter case, the characteristic curves being convex to the abscissa.

In the boiler under consideration, from (14)—

$$p R^2 = 50 ; \text{ also } R = 47.4.$$

Hence—

$$p = 0.0222, \text{ and } q = 10.3.$$

These constants are found to compare favourably with those given by Clark, which are—

Stationary boilers, $p = 0.0222$, $q = 9.56$.
Marine boilers, $p = 0.016$, $q = 10.25$.
Locomotive boilers, $p = 0.009$, $q = 9.7$.

An analysis of the curves given in Mr. Fry's paper, already referred to, give for four series of tests of American locomotives—

$p = 0.0559$, $q = 5.65$ (C = 20 to C = 100)
$p = 0.0444$, $q = 5.14$ (C = 30 to C = 140)
$p = 0.0468$, $q = 5.87$ (C = 20 to C = 120)
$p = 0.0525$, $q = 6.14$ (C = 20 to C = 140)

§ "The Steam Engine," Rankine. Thirteenth edition. Page 294.
‖ "Manual of Rules, Tables and Data for Mechanical Engineers." D. K. Clark. Tenth edition. Page 817.

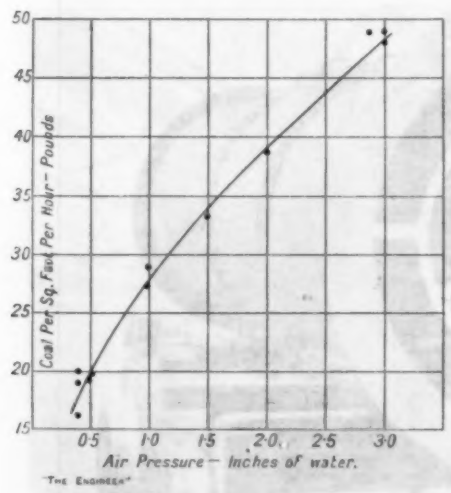


FIG. 1

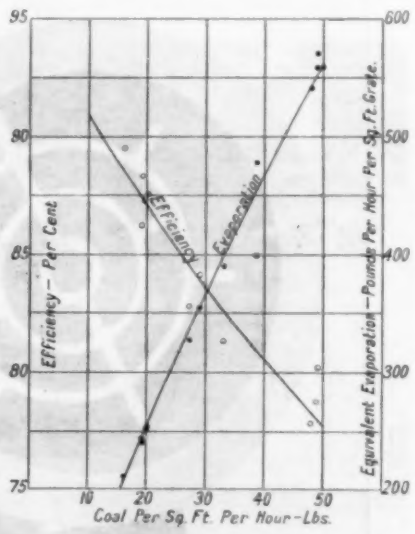


FIG. 2

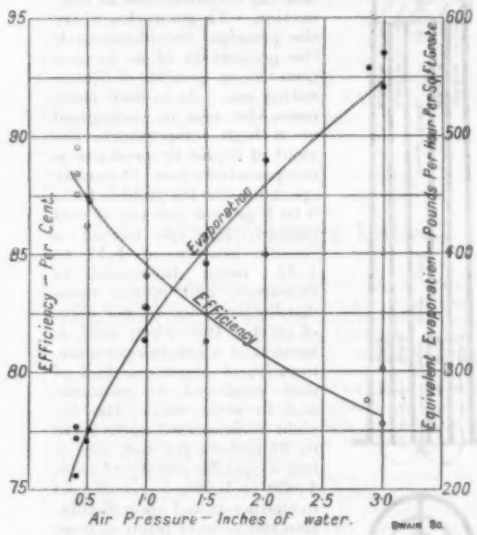

Efficiency - Per Cent.
Equivalent Evaporation - Pounds Per Hour Per Sq. Ft. Grate
Air Pressure - Inches of water.
Evaporation
Efficiency
Dwain Sc.

FIG. 3

Juvenile Employment in South Africa.

Apprenticeship and Education.

The two Bills now before the South African Parliament, one dealing with apprenticeship and the other with Juvenile Affairs Boards, are of more than local interest, and although to some extent based on experience in this country, they merit study by all those who are interested in the problems of apprenticeship. South Africa may be congratulated on the thorough manner in which she is dealing with this very important part of national education and on the profound realisation of its possibilities, in view of her ambition to become a great industrial nation.

The Apprenticeship Bill owes its inception directly to a conference held early in 1918 at Johannesburg and organised by the Juvenile Advisory Board, at which employers, employees, and educationists were present and discussed the whole question of apprenticeship in all its bearings. Other conferences were subsequently convened in various parts of the Union, the main principles of the present Bill were gradually evolved, and finally a draft Bill was presented to the Government by a special committee of the National Industrial Conference. It is hoped that the Minister of Mines and Industries will carry the measure through this session.

Under the new Bill it becomes illegal to employ a minor in any of the scheduled trades—including printing, furniture making, engineering, leather working, woodworking and building—for more than three months unless under a contract of apprenticeship, in connection with which the State assumes certain responsibilities, including scrutiny and registration. Premiums are forbidden, and both minimum and maximum ages are fixed. Transfer and cancellation are provided for under certain circumstances. Contracts must be registered within three months, but registration may be refused by the inspector, subject to approval by the Apprenticeship Committee, if the contract does not appear to be of benefit to the apprentice. To meet the numerous special cases which are bound to arise and which cannot be covered by the Bill, Apprenticeship Committees representing employers and employees in groups of trades will be appointed for periods of three years. These Committees will deal with such matters as the duration of apprenticeship in any particular trade, qualifications required as to age and education, the proportion of apprentices to journeymen, the fixing of wages, investigation of disputes, and, in consultation with the local education authority, the amount of attendance at continuation classes.

Juvenile Affairs Bill.

Juvenile Boards were established in South Africa some time ago to deal with the employment and continued education of the adolescent section of the population; that is to say, those between the school-leaving age and eighteen or nineteen. These Boards, however, have been hitherto more or less of a voluntary nature, with very little legal status and authority, and accordingly, in July, 1920, a conference of delegates from all the Boards in the Union was held in Cape Town, where a resolution was unanimously adopted in favour of legislation conferring definite powers and functions on the Boards, and a Bill was accordingly framed which it is hoped to pass this session. The provisions of the Bill include: notification by school principals of all who are about to become qualified to leave and by employers of all engagements and discharges of juveniles, thus making it possible to maintain an effective register; application of a sound system of continuation schooling and juvenile welfare in a very wide sense of the term; and the establishment of Juvenile Affairs Boards. The Minister is empowered, on the application of a School Board, Divisional Council, Municipal Council, Child Welfare Society, or other recognised body, to appoint a Juvenile Affairs Board consisting of representatives of employers and employees and persons having special knowledge and experience of education and social work. The powers and duties of the Boards are :—(*a*) To compile and maintain a register of all young people within their area with the help of school principals and employers; (*b*) to conduct an employment bureau for juveniles; (*c*) to afford assistance in the choice of suitable employment and to collect and distribute information and advice to this end; (*d*) to supervise generally the welfare of juveniles; and (*e*) to report on any matters concerning their training, employment and welfare.

Mr. Frank McGregor, Union Organising Officer to the Juvenile Advisory Boards, points out that compulsion will only exist in regard to the means for securing information, and complete freedom will be given to the child and his parents to choose his own course; and there is, moreover, no desire to interfere between the employer and his young employee; the Board will act mainly in an advisory capacity.

Developments in Power Station Design.

No. X.*

As we pointed out in the first article of this series, one of the matters which was referred to in the Coal Conservation Sub-Committee's Report of 1917 was the possibility of extracting by-products from the coal. It was suggested that the new super power stations should be designed so that as methods were perfected for extracting by-products from the fuel before using it for producing electric power, the by-product plant could be combined with the power station. Little attention appears to have been paid to this matter by the bulk of electrical engineers, but it is not, of course, an unimportant one. If the raw coal can be treated before reaching the domestic consumer, and the power station, by a process which will extract the valuable by-products in the forms of petrol, oils, paraffin wax, pitch, &c., and a carbonaceous residue in the form of a smokeless and easily ignitable fuel can be secured, the process is surely well worth considering.

By submitting the raw coal to low-temperature carbonisation these results can be secured; but what engineers seem to be in doubt about is whether at this juncture the system can be made to pay. The two principal systems of carbonisation at present in use are (1) that associated with coke ovens for the production of metallurgical coke, the demand for such coke being limited to blast-furnaces and cupolas, and (2) carbonisation in connection with gasworks, where the principal consideration is the production of as large a quantity as possible of illuminating gas. As in both these cases the coal is carbonised at a high temperature, the yield of liquid by-products is comparatively low. Generally speaking, the tar yield is from 8 to 9 gallons per ton of coal treated, the tar having a specific gravity of 1.15 to 1.22, being benzenoid in character, and giving upon distillation some 50 per cent. of pitch. But when coal is treated at a low temperature, namely, at about one half of that employed in gasworks and in coke ovens, the tar yield is increased to from 18 to 22 gallons per ton, and it has a specific gravity of from 1.030 to 1.060, is paraffinoid in character, and upon distillation the yield of pitch is from 28 to 35 per cent. Gas coke is practically limited to industrial requirements on account of the draught necessary to burn it, whereas the low-temperature coke, which contains from 8 to 10 per cent. of volatile matter, ignites easily and burns without smoke. It will be seen, then, that the production of oil for illuminating purposes, for Diesel engines, and for fuel is considerably greater when the coal is carbonised under low-temperature conditions. At the Fraser and Chalmers Eng ineering Works, owned by the General Electric Company, Ltd., low-temperature carbonisation plant is being built to the designs of Mr. C. W. Tozer, A.M.I. Mech. E., but before dealing with these works the financial side of the subject should be considered. Of course, the utilisation of any system of coal treatment can only be justified by reducing the cost of the fuel supplied to the boilers, irrespective of whether the fuel be solid or gaseous. In other words, if the cost of treatment is 5s. per ton, the products recovered must realise 5s. plus amortisation, establishment charges and interest on capital. Mr. Tozer states that it is anticipated that the price of clean slack, either washed or unwashed, is expected to be in the neighbourhood of 11s. to 12s. per ton, but in the profit and loss estimate —Tables I. and II.—which he has compiled the price of slack has been taken at 14s. per ton, and the yields are based upon results actually obtained from the treatment of Yorkshire slack coal having the following analysis:—Volatile matter, 32.85 per cent.; fixed carbon, 58.31 per cent.; ash, 8.84 per cent.; whilst the analysis of the low-temperature coke is:—Volatile matter, 7.7 per cent.; fixed carbon, 83.30 per cent.; and ash, 9.99 per cent. The estimated cost of a plant to carbonise 500 tons of coal per day, including that necessary for by-product recovery, is £200,000. The estimated annual expenditure is set forth in Table I., whilst the second table gives the estimated annual revenue.

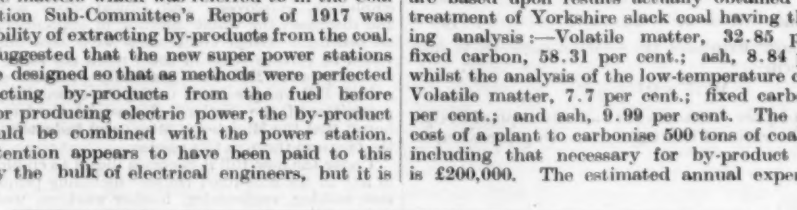


FIG. 48—DIAGRAM OF BY-PRODUCTS RECOVERY IN A POWER STATION

FIG. 49—SECTION OF TOZER RETORT

The £52,312 10s. represents the cost of producing 126,000 tons of smokeless fuel, the cost per ton working out at 8s. 3d., as compared with 14s. per ton for the original coal, or expressed in other words, the saving on the purchase of 126,000 tons of coal would be £35,888, representing a further 17.9 per cent. interest on the capital. It has been assumed in arriving at these figures that when burnt under the boilers the low-temperature coal will show the same efficiency as the original coal, and considering that the former fuel is smokeless, and that the air supply for combustion would be brought nearer to the theoretical value than is possible when burning a bituminous slack, the assumption appears to be amply justified. As an alternative to consuming the low-temperature coke under boilers, it could be gasified in by-product recovery producers, and the boilers could be fired with producer gas. This, however, would involve additional capital for a gas producer installation, and would only be profitable if the sale of sulphate of ammonia was favourable. The yield of sulphate of ammonia would be dependent upon the nitrogen content of the original coal, and as sulphuric acid is necessary to produce the ammonium sulphate, the price of the acid enters into consideration. We hope to give later the results obtained by a combination of low-temperature carbonisation and gasification of the resultant fuel. In Mr. Tozer's opinion, the only way to deal with the highly coking bituminous coals is first to carbonise them by the low-temperature process when not only are the valuable oils obtained, but the resultant fuel is ideal for use in gas producers. The object of this first carbonisation process is to distil the coal under such conditions that a high yield of oils is obtained, the yield of ammonia being rather low and the residue of smokeless fuel contains from 8 to 10 per cent. of volatile matter. When this fuel is gasified the balance of the recoverable nitrogen is secured as ammonia, and a good yield of gas of good calorific value is secured.

TABLE I.

Estimated Annual Expenditure.

	£ s. d.	£ s. d.
180,000 tons of slack coal at 14s. per ton		126,000 0 0
Carbonising costs and distillation of oils at 5s. 6d. per ton		49,500 0 0
Amortisation at 5 per cent. on £200,000		10,000 0 0
Maintenance and upkeep at 2½ per cent. on £200,000		5,000 0 0
Royalties at 6d. per ton		4,500 0 0
Administration charges, &c.		5,000 0 0
		200 000 0 0

TABLE II.

Estimated Annual Revenue.

	£ s. d.	£ s. d.
400,000 gals. of motor spirit at 2s. per gallon	40,000 0 0	
371,000 gals. of illuminating oil at 1s. per gallon	18,550 0 0	
1,365,000 gals. of crude lubricating and fuel oils at 5d. per gallon	28,437 10 0	
700,000 gals. of refined tar acids at 1s. 9d. per gallon	61,350 0 0	
4300 tons of bituminous pitch at 50s. per ton	10,750 0 0	
1700 tons of ammonium sulphate at £8 per ton net	13,600 0 0	
		172,687 10 0
		27,312 10 0
Interest of 12½ per cent. on capital		25,000 0 0
		£52,312 10 0

This gaseous fuel can be burnt under large batteries of boilers with good efficiency, owing to the clean condition in which the surfaces can be kept, and the maintenance of complete combustion. Constant and equal distribution can be maintained, as there are no fire doors to be opened. The diagram—Fig. 48—shows the cycle of operations. The first process consists of carbonising the coal at a low temperature and recovering the liquid products and a portion of the ammonia. Next, the resultant coke is gasified and the bulk of the ammonia is recovered, whilst the final process consists of converting the gas into electricity. This cycle of operations recovers every valuable constituent composing the raw coal and only leaves an ash residue, and even it is useful for brickmaking, &c. The expression "low temperature" is purely a relative one in respect to the temperatures employed at gasworks and in coke ovens for the treatment of coal to produce illuminating gas, metallurgical coke, &c. The temperatures which are employed in connection with gas and coke oven works, and which may be termed high, range from 2000 deg. to 2200 deg. Fah. To maintain these temperatures for any length of time retorts or chambers of fire-clay or other refractory material are essential.

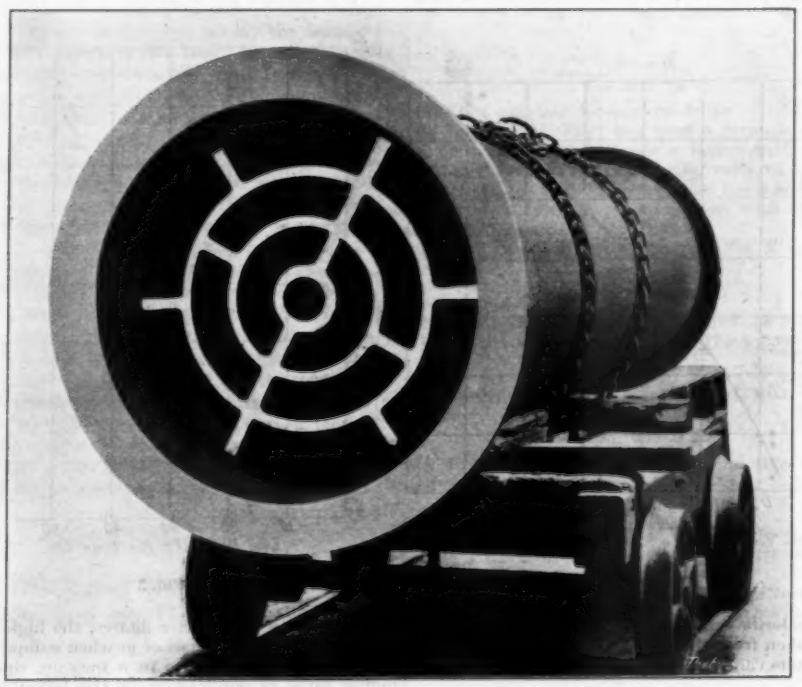


FIG. 50—END VIEW OF TOZER RETORT

* No. IX. appeared September 16th.

The first cost of these is high and their life is short, but with low temperatures of from 900 deg. to 1200 deg. Fah., cast iron retorts can be used. They are cheap and experience extending over a number of years has shown that they are practically indestructable. The temperature difference in the two processes is some 1000 deg. Fah., and the effect of this difference on the yield of by-products was referred to at the outset.

The Tozer retort, which is constructed at the Fraser and Chalmers Engineering Works, Erith, and is shown in Figs. 49 and 50, is, as already indicated, made of iron. The inner tube, formed by the surrounding annuli, is not filled with coal, but acts as a gas passage connecting the upper and lower end of the retort, so that the gases evolved can pass partly upwards through the body of the coal and partly downwards. Those gases that pass downwards find their exit through the centre tube and meet in the upper part of the retort the gases which pass directly upwards from the upper half of the charge. There is undoubtedly a neutral point, which naturally varies, where the gases are divided into an upward and downward stream, thereby accelerating their exit velocity. The charging and discharging doors are made tight by a special arrangement, and the lower door is balanced by counterweights. The doors are easily locked. When carbonising a bituminous coal the coke comes out in slabs, having a length practically the same as that of the retort and corresponding exactly with the shape of the cells. If the coal is a non-coking one, the coke comes out in practically the same physical condition as the entering charge. The retort will deal with practically every description of carbonaceous material, coking and non-coking, and peat in every physical condition, and will carbonise and produce coke from colliery sludge or washings. The retorts are heated by a specially designed recuperative setting. Fig. 51 shows a setting of six of these retorts which have been in constant use for over seven years, and which show no signs of deterioration. The retorts will hold about a quarter of a ton per charge, but they are not by any means the largest that have been constructed. Iron has a conductivity about ten times greater than that of fire-brick and similar refractory material, and advantage is taken of the good conductivity to divide the retort, as indicated, into a number of concentric chambers or annular spaces, in which the coal is separated into thin layers. The walls of these chambers are cast integrally with the outer shell, and are connected by a number of ribs which extend the full length of the retorts and serve to conduct the heat to the inner chambers. The design, it is claimed, gives the retort a very high efficiency, as a large charge can be carbonised in a small space and with a minimum amount of labour, whilst the shape of the retort and the material of which it is made enable

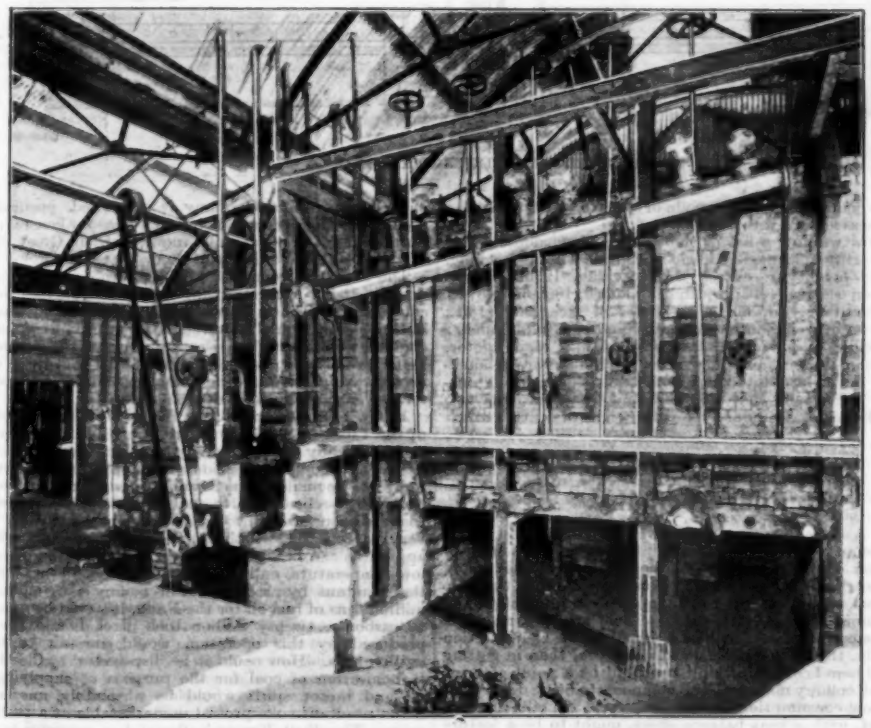


FIG. 51—RETORTS WITH LOCKING GEAR AND GAS MAIN

it to stand the pressure due to expansion of the charge, thus ensuring the production of a dense homogeneous smokeless fuel. Low temperature hydrocarbon gases are extremely sensible to temperature, and it is for that reason that the period of carbonisation must be as short as possible, and the gases must also be removed rapidly. The double exit for the gases enables this to be brought about with the aid of the partial vacuum which is maintained in the system.

The retorts shown in Fig. 51 belong to a low-temperature carbonisation plant which has been erected at Battersea. The coal or other carbonaceous material for treatment is delivered in the yard and raised to the charging stage by means of a bucket elevator. The six annular retorts are arranged in two rows, and they are all built in a brickwork setting. Each retort is surrounded by a ring of brickwork to prevent flame impinging direct on the cast iron casing, and the space between the retort and brickwork acts as a heating flue. In each of the exit gas flues is a damper which controls the temperature of the retort. After passing through the damper, the exit flue gases make three horizontal passes in a recuperator flue, the secondary air for the combustion of the heating gases being passed through boxes at right angles across this flue. The draught is maintained by a brick chimney, 45ft. high. The bottom interlocking covers of the retorts are coupled together in pairs by means of a 3in. shaft, and they are opened and closed by means of hand wheels and screws operated from the charging platform. A special form of joint makes the covers air-tight under all conditions. The semi-coke or smokeless fuel is discharged on to a hearth underneath the retorts, and after it has been quenched it is wheeled away to the coke stack. The mouthpieces at the tops of the retorts are arranged to carry the covers and also the gas outlet. Charging is done by dropping a predetermined quantity of coal into the retorts. The gases evolved during carbonisation are passed through a dry collecting main to a condenser which under ordinary conditions is operated as an atmospheric condenser. On cooling the gases the condensible products, such as tar and ammoniacal liquor separate out and flow into the

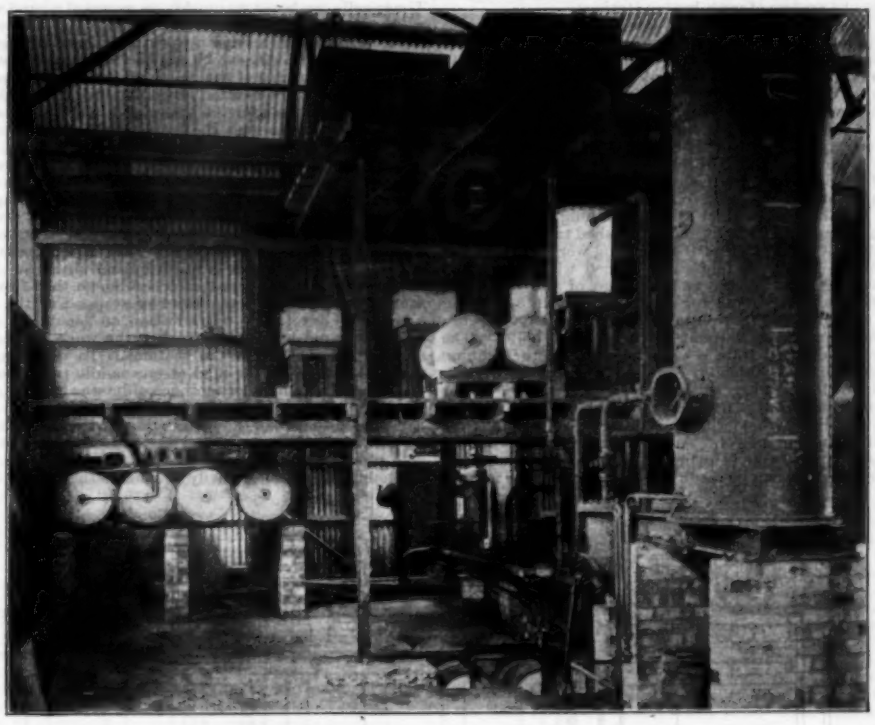


FIG. 52—LIGHT OIL RECOVERY PLANT, SCRUBBERS, AND TANKS

receivers. After leaving the condenser the gases are passed through a tar extractor, in which the tar fog is taken out, and the whole of this plant is operated under a negative pressure, which is produced by an exhauster. The gases are then passed through a scrubber packed with coke, in which the balance of the recoverable ammonia is extracted from the gases by means of a water spray. Finally, the gases are passed through another scrubber in which they are brought into contact with gas oil, which abstracts the light hydrocarbons from the gases, and the oil wash is afterwards treated to recover such hydrocarbons as motor spirit. Fig. 52 shows the light oil-recovery plant, with rotary scrubbers and light oil and spirit storage tanks.

A Very Large Lathe.

THE unusually large lathe illustrated herewith and in our two-page Supplement—probably the largest ever made in this country—has just been completed by Thomas Shanks and Co., of Johnstone, Scotland. This firm, it may be remarked, has been in existence since 1824, and has been continuously engaged in manufacturing large machine tools. During the war it had, like other firms, to turn aside to the manufacture of lighter tools, but now, with its works greatly increased in size and with a foundry added, it has again resumed the building of machines of the largest and heaviest class.

The lathe illustrated has been supplied to Japan through Messrs. Takata and Co., London, and is intended for the very largest work. It is normally capable of swinging face-plate work up to 18ft. 6in. in diameter and of sliding work 16ft. 6in. over the saddles, and admitting 40ft. between centres. To meet the contingency of still larger work it is, however, designed to admit 12in. packings, so that 18ft. 6in. diameter could be machined over the saddles. In addition, the slide bed is prepared at the end for extension to deal with longer work if found necessary in the future.

The outstanding features of the lathe, apart from its mere size, include the means taken to secure that accurate work can be produced, heavy cuts taken, and a large variety of work dealt with. The great width of base of the fast and loose headstocks, together with the design of the front journal of the main spindle are intended to ensure that the work is turned perfectly round and not oval. The massive character of the headstocks and slides and the provision made for taking the stresses thrown upon them allow heavy cuts to be made with ease, while owing to the construction of the saddles and loose head short work can be done between centres without undue overhang of the loose head spindle, all of which features are needed to fulfil the purpose for which the lathe was made. Safety interlocking devices are provided at the fast headstock and on the saddles so that no conflicting gear wheels can be engaged. The oiling details, another feature to which attention may be called, are unusually complete and are so grouped that the attendant has no excuse for overlooking any of them. The guarding of the gear wheels

is so thoroughly carried out that the makers claim the protection afforded to be unique for a lathe of this size.

The ease of control of the various movements has received special attention. Although each saddle complete weighs 21 tons and the loose head complete weighs 30 tons, these items can be moved in either direction independently or all together with the greatest of ease by means of power movements derived from an auxiliary motor. In addition, hand motions are provided for final setting and are so arranged that they can be operated by the attendant without fatigue. The speeds of the face-plate can be varied at will at any of the four saddles by means of a system of push-button stations.

In its general design the lathe is built up of the largest individual pieces compatible with the limits of railway transport, and in this respect is claimed to mark a complete departure from the common method of obtaining a great height of centres by merely introducing a number of intervening packings. Attention is also called to the compactness of the design which eliminates straggling parts and secures economy of floor space.

Reviewing the design of the more important details, we will first deal with the fast headstock. This headstock has a base 14ft. 7in. wide to ensure stability. It is fitted with a hard forged steel spindle running in gun-metal bearings and with its front journal finished truly cylindrical to within .0002in., so that the resulting work is round and not oval. The back journal is formed with a series of thrust rings to take the end pressure of the cut. The spindle has a large-diameter forged collar with a tapering end, to which the face-plate is fitted in order to secure accurate surfacing without stressing the bolts. The driving is effected from a variable-speed motor running at 260 to 650 revolutions per minute, and giving with the gearing at least 120 speeds for the face-plate. The motor is connected to the makers' patented arrangement of gearing whereby no wheels are engaged unless they are transmitting power. All the changes of speed are easily and quickly made by means of two levers so arranged that no mistake can be made by the operator. As an indication of the small amount of power absorbed by the gearing, the makers state that when turning up the face-plate with a surfacing cut of 1in. by $^1/_{16}$in. and two rim cuts of $\frac{1}{4}$in. by $\frac{1}{4}$in. only 7 horse-power was absorbed. It may be mentioned in passing that the face-plate and spindle weigh 37 tons. The whole of the driving gear, it will be seen, is thoroughly enclosed.

The face-plate is of very strong design and is capable of carrying a job weighing over 100 tons without other support. At the back it has a turned ring, on to which is shrunk a machine-cut steel toothed ring of fine pitch which is completely enclosed by a protective guard. The front of the face-plate is provided with four very heavy forged steel jaws tongued into the face-plate and moved by means of large diameter forged steel screws. Each jaw is provided with a supplementary removable forged steel jaw for gripping work of small diameter.

The slide bed is of Messrs. Shanks double type and is of great width and depth. It consists of two main longitudinal beds jointed together by a central bed which acts as a distance piece, but does not carry any of the saddles or the loose head. The front portion of the slide bed is fitted with a large diameter forged steel guide screw, used exclusively for screw cutting, while both the front and back portions are fitted with machine-cut steel racks for the sliding feeds. The various parts of the bed have planed and checked staggered joints so that when placed on its foundations the whole bed is thoroughly rigid.

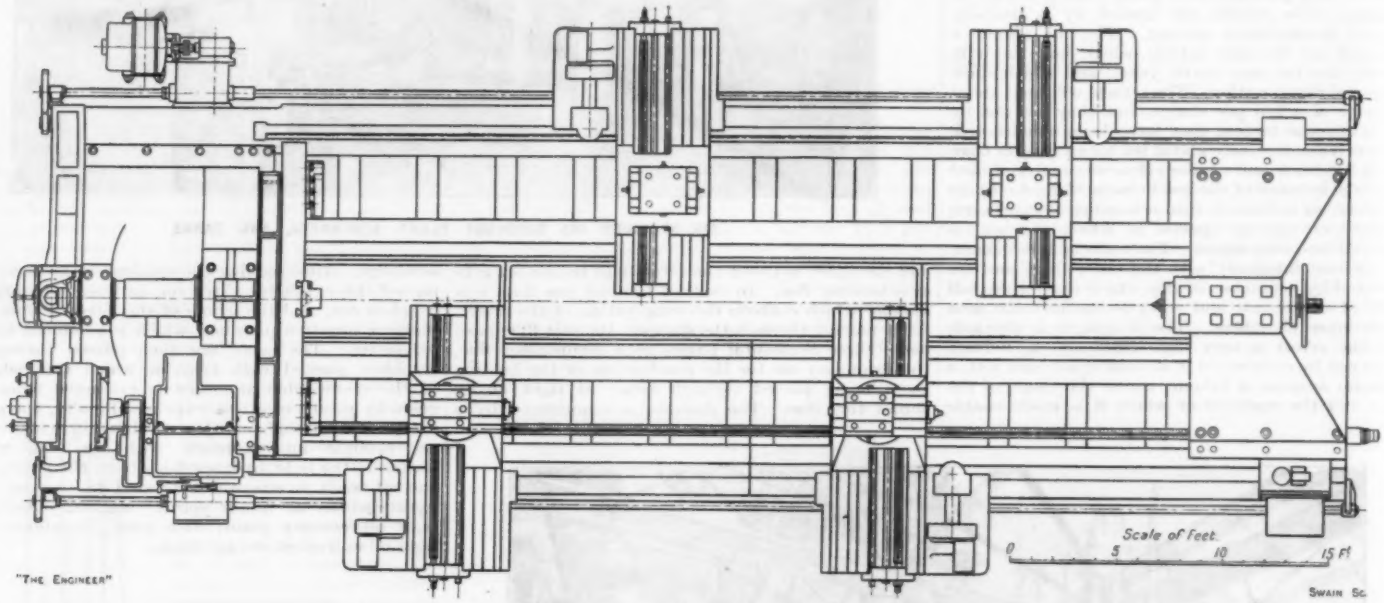
Four saddles are provided, two on the front and two on the back slide bed. The saddles are very deep and have very long guiding surfaces of the narrow guide type to prevent cross-winding. Each saddle at the front is fitted with a self-acting surfacing rest and with a swivel rest, which is also self-acting at any angle. The saddles at the back have each a self-acting surfacing rest, but the compound rest does not swivel and is especially designed to resist the upward stresses of back cutting. The compound rests have, however, a longitudinal self-acting feed. All four tool slides are of forged steel. The rack sliding and surfacing feeds are independent for each saddle and are derived from the longitudinal feed shafts, which are supported in patented self-acting tumbling bearings. The surfacing screw in each saddle is provided with ball-thrust washers so that the heavy pillar slides may be easily adjustable by hand. Each saddle has a hand and a quick-power reversing movement, enabling it to be set in position easily and quickly. To prevent any mistake on the part of the operator, an interlocking system is provided with a special selector device, by means of which the attendant, having determined whether the operation is to be sliding, surfacing or screw-cutting, puts his handle into the corresponding notch and thereafter can only put into action the motion controlled thereby.

The movable headstock is mounted upon a heavy sandwich plate and is provided with special clamping details, with a cross adjustment to secure perfectly parallel sliding, and with power motion in either direction along the bed. The spindle can be set up quickly by means of a hand wheel, while the final adjustment of the centre in the work can be made with power through a worm wheel and disengaging worm. The whole headstock can be very securely clamped to the bed by means of the bolts and details supplied, but as an additional precaution a positive lock is provided, so that it is impossible for the loose head to spring away out of the work. Although the total weight is 30 tons, the loose headstock can be moved quite easily by hand.

All the power movements to the saddles and loose head are obtained from an auxiliary 30 horse-power non-reversing motor. This motor is of the non-reversing type because the saddles and the movable headstock are each fitted with independent reversing means. The various speeds of the face-plate are, as previously stated, controlled by means of a system of push-button stations. These stations are placed one at each saddle, so that from any saddle the lathe can be started or stopped or the speed accelerated or retarded. In addition, an "inching" speed, which is found highly useful when the work is being set, can be obtained from the stations. To guard against accident caused by the man at one saddle trying to start the lathe while a man at another saddle was in a dangerous position, an extra push button marked "lock and free" is provided to enable the man in danger to protect himself by locking the whole control system. A push button is also provided on the fast head for "inching" the motor to enable the operator easily to change the gears. Every gear wheel in the lathe is made of steel so as to permit the very heaviest work to be done.

Below we give a list of the leading dimensions of this noteworthy machine:—Height of centres without packing, 111in.; height of centres with packing, 123in.; admit between centres, 40ft.; width of slide bed, 18ft. 6in.; overall length of bed, 60ft.; diameter of face-plate, 15ft.; diameter of front journal of main spindle, 27in.; diameter of spindle of movable headstock, 15$\frac{1}{2}$in.; main motor, 120 horse-power; auxiliary power motion motor, 30 horse-power; weight of lathe at 40ft. between centres, 330 tons.

We understand that Messrs. Shanks have in hand two large lathes of a similar type with height of centres 81in.



PLAN OF THOMAS SHANKS AND CO.'S ONE HUNDRED AND ELEVEN-INCH LATHE

Fuel Economy.*

IT is an auspicious development, to which this Institution has contributed much in the past, and stands ready to contribute even more in the future, that the two problems of an improved technique in the production and of a more scientific utilisation of coal are now receiving the attention they deserve. Looking at the question broadly, there is more waste in using coal than in getting it, and here I certainly think it should be a point of pride with all colliery managers and engineers to bring down their own fuel consumption to the minimum. An effective fuel control, with a heat balance sheet, ought to be a feature of every efficient colliery. If all the collieries in the kingdom had modern plants of the best description, it has been estimated that their consumption of coal, which averages from 6 to 8 per cent. of their output, would be about half what it is to-day. I venture to think that in a matter of this kind it is up to the colliery managers and engineers to set the finest example of efficient practice.

One point more. For some time past, particularly during the war period, the grading and cleaning of the coal has been most unsatisfactory, and a very inferior product has been placed on the market. Sir George Beilby recently quoted an analysis of the coal received at the Central Electric Supply Company during the first quarter of the present year. Its calorific value was 10,581 B.Th.U., as against 10,800 in the winter of 1914–15; its cost was 45s. 2d., as against 14s. 6d.; and its ash content was 18.4 per cent., as against 13 per cent.—in other words, an extra hundredweight of ash for every ton supplied. About a sixth of all the coal that is used in Great Britain is burned, and, of course, largely wasted, in our ten million private dwellings. If we adopted the central heating system in our houses and used an open soft coke fire to supplement hot-water pipes and radiators, an enormous saving of coal would be effected—perhaps as much as one-half. I have even heard it maintained that without this uncongenial resolution, and merely by the universal introduction of a proper and economical grate, we could save 20 per cent. of the coal that at present sends most of its heat up the chimney. I need not tell you that while the popular view of coal is that it is something to be burned, the scientific view is tending to be precisely the opposite. It is that coal is too valuable to be burned, that to burn it is to squander it, that the by-products of coal are of greater moment than the coal itself, and that not until these by-products have been extracted should the residuum be used for industrial or domestic purposes.

People are anxious to know, and are determined, if they can, to find out, whether the most is being made of the greatest natural resource that this kingdom possesses; and, if not, why not! They want to know whether a dispensation under which at least three-fourths of our coal is used directly, and without any effort being made to conserve the by-products, is a wise dispensation. They ask for a reason that will explain why Germany before the war, with a coal output of some 70,000,000 tons less than our own, was producing almost twice as much coke, about sixteen times as much patent fuel, and one and a-half times as much ammonium sulphate. They have heard of the great strides that other countries have made in developing powdered fuel, and they wonder why so very few plants of this kind are operating in Great Britain. They are told of the waste gas from blast-furnaces which in Belgium and in Germany is conserved, purified and used in gas engines for blowing as well as for general power purposes, and they naturally inquire why in Great Britain it should not be similarly utilised.

The supreme industrial search of to-day is for cheap power. It has been said that if all steam engines were as efficient as the best, 50 per cent. of the coal now used in raising steam would be saved. If gas producers and gas engines were to replace the ordinary steam engine and boiler installation, it has been calculated that there would be a very big saving in the amount of coal now consumed for power purposes in mines and factories.

In his recent James Forrest Lecture on "Fuel Problems of the Future," to the Institution of Civil Engineers, Sir George Beilby gave a highly interesting survey of the varied and complex considerations that arise before any reply can be made to the familiar question: Can a smokeless fuel be relied upon to enable the supplies of raw coal to be dispensed with? That is a problem which turns very largely on whether an economical and efficient apparatus can be devised for the carbonisation of coal at low temperature, and whether a market can be found for the resultant by-products. For instance, to obtain one million tons of fuel oil for the Navy, it would be necessary to carbonise twenty million tons of coal, and the coke produced by this operation would amount to fifteen million tons. How could it be disposed of? Clearly the carbonisation of coal for the purpose of supplying fuel oil and motor spirit would be absolutely uneconomic if the resultant coke proved unmarketable at a profitable price. The Fuel Research Board has accordingly been led on to probe into at least three very considerable problems:—(1) The use and value of this coke for the direct firing of steam boilers; (2) its gasification in producers for the manufacture of low-grade fuel gas and the recovery of its nitrogen as ammonia; and (3) its use for industrial and domestic heating—possibly under legal compulsion—either directly as it comes from the retorts or after its conversion into briquettes.

The ramifications of the coal problem are, in fact, without end, and a new extension to them has recently been given by the increasing supply, the easy utilisation and the high calorific properties of petroleum products. The use of town gas as a fuel for industrial purposes, present methods of gas heating, the most efficient way

* From Sir J. Cadman's presidential address, Institution of Mining Engineers.

of employing low grades of fuel gas for heat and power purposes, the supply of electricity in bulk, all come within its range and involve a vast series of complicated inquiries. I submit that these are problems to which we of this Institution must remain fully alive. Some, at least, of the responsibility for investigating them will devolve upon us. There is a certain justice in the complaint that science has achieved of recent years little for coal in the way of developing, cheapening and popularising its by-products and its proper use as compared with what they have done for oil. It would seem as though oil and the possibilities of the internal combustion engine had, during the past two decades, been but too successful in turning scientific research away from the problems of coal. If that reproach is based, as I think in part it may be, on fact, it is clearly one of the functions of such an Institution as ours to do what we can to remove it. It should appeal to us both technically and nationally. For Great Britain, coal, I sincerely believe, is the problem of problems. What we do or do not do in regard to coal in the next few years will give the measure of our capacity to weather the difficulties, and to grasp the conditions of the unexampled age bequeathed to us by the war.

TENDERS FOR CHINESE RAILWAY MATERIAL

THE *Hong Kong Daily Press* of July 22nd gives the following particulars concerning contracts recently placed for locomotives and rolling stock for China. It will be noticed that except for five engines, ordered in America, a Belgian firm secured all the orders.

"The first contract for thirty 'Prairie' type locomotives was awarded to the Forges Usines et Fonderies de Haine-St.-Pierre (near Charleroi), whose price was Belgian francs 410,000 per locomotive, or approximately £9150. The lowest British tender was £13,075, c.i.f. Liverpool; the highest was £19,750, quoted by Messrs. W. G. Armstrong for five locomotives of the required type.

"The contract for the six 'English type' locomotives went to the same makers, whose price, duty and famine-surtax included, was Belgian francs 434,660, or approximately £9675. The lowest British bid was £11,000 each with an additional £4500 for spare parts; the highest British bid was £17,280.

"The contract for the two 'Mikado' type locomotives was secured by the Mitsui Bussan Kaisha for the American Locomotive Company, whose price was gold dollars 52,000 each, or approximately £13,000. The only British bid was £14,904.

"The price quoted by the same company for the three 'Pacific' type locomotives was omitted from the list in our possession. (In a list we have, it is given as Belgian francs 515,000; British tenders were £14,310 and £16,500.)

"All the contracts for goods wagons were awarded to the Compagnie Centrale de Construction à Haine-St.-Pierre, on whose behalf Messrs. Fearon, Daniel and Co. tendered. The prices at which these contracts were secured are set forth below, with the sterling equivalent, and the British prices in brackets:—

"One hundred open wagons: Belgian francs 31,325 each, or approximately £666 (£1016 to £1340).

"One hundred covered wagons: Belgian francs 33,965 each, or approximately £722 (£1383 to £1610).

"Forty covered wagons: Belgian francs 33,965 each, or approximately £722 (£1160 to £1510).

"It will be seen, therefore, that in many cases the British tenders were more than double those of the Belgian manufacturers, and that in only two instances were British prices within a reasonable distance of those of their competitors.

"The moral, for the British engineering firms, and the associated labour organisations, is too obvious to require statement."

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

PROPOSED FACULTY OF CIVIL ENGINEERS.

SIR,—At a time when engineers are considering their status and interesting themselves about their education and professional training, as one who has been trained as a civil engineer and surveyor, I take the liberty of submitting the following suggestions and notes.

In a general sense, engineering is divided into six great provinces, namely, civil, mining, mechanical and electrical engineering; civil and naval architecture. All the provinces have expanded so much that they may now be considered separate professions, more or less connected with each other. As the I.C.E. has expanded in all directions, and includes all branches of engineering, it is impossible for it to do all that might be done were its interests confined to one province. Professional men consider their occupation in a different light from that of the contractors, who have commercial interests, or those who engage in both occupations. The practice of some engineers includes everything in all the provinces, while that of others is entirely confined to one particular thing. But the most desirable practice is that of engineers who apply themselves to the study of works in one particular province. From a professional man's point of view, the profession is weakened by bodies such as the Waterworks Engineers, the Sanitary Engineers, and Municipal and County Engineers having Institutions of their own. If engineering is to be considered a profession, it must not be broken up into small parts such as the above. Every section of engineering must be included in one of the foregoing provinces. It is also a matter for regret that the engineering officials in the service of Corporations and limited companies are taking the place of engineers in private practice.

All the professions have societies reserved exclusively for themselves, except the ones connected with engineering. The "Advocates," "Physicians and Surgeons," "Procurators," "Surveyors," "Actuaries," "Chemists" (analytical) have each formed a Faculty for themselves. I therefore suggest that the civil engineers form a society exclusively for themselves, and that it be called "The Faculty of Civil Engineers." As there appear to be quibbles as to what is meant by the words "Civil Engineering," I will endeavour to make this clear, and so avoid misunderstandings.

The Faculty would understand that civil engineering was the profession that dealt professionally with constructional and sanitary engineering and land surveying. The engineers being civilians and designated civil engineers.

The following is an attempt to name the works that come under this engineering province:—Bridges, aqueducts, viaducts, railways, tunnels, tramways, roads, streets, town planning, harbours, docks, breakwaters, piers, lighthouses, reclamation of land, rivers, canals, irrigation, water-power works, waterworks, sewage, drainage, purification of rivers and streams, factories and buildings connected with engineering undertakings, land surveying and other works of a similar kind. This Faculty to have power to expand and so include all new works of a like kind which at present are unknown. The Faculty would also engage in research work.

A professional training recognised by the Faculty to mean that a candidate had served a professional apprenticeship in civil engineering under a civil engineer (as understood by the Faculty) and had not less than five years' experience. The Faculty to have power to grant two qualifications, namely, Practitioner-graduate, Faculty of Civil Engineers (P.G.F.C.E.); Practitioner, Faculty of Civil Engineers (P.F.C.E.). The qualification "Practitioner-graduate" would be conferred on candidates who had the recognised professional training in civil engineering, and, in addition, had qualified in all the subjects at the Faculty's examinations. The qualification "Practitioner" would be conferred on candidates who had the recognised professional training in civil engineering, and, in addition, hold a University degree, either "B.E.," "B.Sc. (Eng.)," "M.A.," or B.Sc. (mathematics and *N.* Philosophy)," or who, in addition, had qualified by examination as "A.M. Inst. C.E." A Practitioner, if he desired, could become a Practitioner-graduate by qualifying at the Faculty's examinations.

Both of the above qualifications would be considered on an equal footing in the Faculty, and the holders of them would each be entitled to add the letters "P.G.F.C.E." or "P.F.C.E." after his name, as the case might be. The additional letters, representing either of these qualifications after the name of one holding the qualification "A.M. Inst. C.E." would indicate the province of engineering he was professing.

There are three examinations in connection with the "P.G.F.C.E." qualifications, namely, the entrance examination, the intermediate examination, and the final examination. The examinations to be held every six months.

(1) *The Entrance Examination.*—Subjects: Practical plane and solid geometry and projection, mathematics, and natural philosophy. The standard not to be below the University matriculation examination for a degree in science.

(2) *The Intermediate Examination.*—Subjects: Mathematics and natural philosophy, and (to the extent that they apply to engineering) chemistry and geology. The standard not to be below that required for a degree in engineering science.

(3) *The Final Examination.*—Subjects: Applied mechanics, hydraulics, strength of materials, theory of structures, and land surveying. The standard not to be below that required at a University final examination for a degree in engineering science.

Pupils who had commenced a recognised professional training in civil engineering would be eligible for the qualification "P.G.F.C.E." on condition that they qualified at the three examinations conducted by the Faculty. The final examination to be taken after the completion of apprenticeship. The Faculty to exclude rigorously all others from obtaining its qualifications or becoming a member of it.

As the education of engineers is of very great importance, it would be the intention of the Faculty that its examinations were of the highest standard. Further, as the candidates would probably be engaged in business, their time for private study would be limited. Therefore, in order to adopt a high standard of examination, candidates at the intermediate and final examinations should be allowed to take what prescribed subjects they desired at a sitting, until they had qualified in all the subjects. The proposed Faculty's examinations would be supplementary to a professional training in civil engineering, and not a substitute for it.

No society can claim a sole right to the title "Practitioner," but a sole right might be obtained if the Faculty in which the Practitioner practiced were stated. The Faculty should have power to prevent unauthorised persons from using its titles in connection with its province in engineering.

The plan of adopting a course of study of the highest standard, and the bestowing of a dignified title on its members would go a long way in raising the status of all concerned. Perhaps the mechanical and electrical engineers might see their way to form an exclusive society for themselves. But as machinery and prime movers form another province in engineering, no matter what the motive power is, it might be desirable that all machinery came under one Faculty instead of having a Faculty for each. This Faculty to be reserved for those who had completed an apprenticeship recognised by this Faculty in a drawing-office, and who had been trained in designing machinery, and who desired to practise as professional engineers and not as contractors. The examination subjects, &c., to be arranged by those concerned in forming this Faculty. Further separate Faculties could be formed to represent the professions: Mining engineer, civil architect and naval architect. Perhaps Marine Architect might be considered a better name for one who included all ships in his province. Overlapping cannot be avoided, but the Faculty of each province could arrange not to trespass to any great extent on the province of another. The "F.C.E." might arrange that it would restrict itself to the mechanism and machinery forming a part of civil engineering undertakings, such as that required for movable bridges, dock gates, lighthouses, &c.; but that the machinery in a factory required for industrial purposes would be considered outside its province. The Faculty of Mechanical and Electrical Engineers would restrict itself to the structural work required for cranes, &c. In the case of buildings, the "F.C.E." would restrict itself to warehouses, sheds, and plain buildings forming a part of civil engineering undertakings, and factories; but such buildings as a railway hotel, &c., would be considered outside its province. The architect being restricted in constructional and sanitary engineering to that required for buildings. The overlapping that concerns the other proposed Faculties could be agreed upon.

A CIVIL ENGINEER AND SURVEYOR.

September 15th.

A NEW blast-furnace has been put up by the Yangtze Engineering Works at Seven Mill Creek, near Hankow, China, and another has been ordered from England.

Supercharging in Petrol Engines.

IN a paper which he read before the Institution of Automobile Engineers recently, Mr. H. R. Ricardo gave some particulars of a series of very interesting experiments on the effects of supercharging on the economy and output of petrol engines.

In the first part of the paper he showed how the efficiency of the engine should increase as the heat value of the combustible charge is reduced. The physical characteristics of petrol vapour-air mixtures are, however, such that they have only a very narrow range of burning, and cannot be made weaker, under ordinary conditions, than about 85 B.Th.U. per cubic foot.

Three sets of experiments were carried out by the author, with the object of investigating the subject, and may be divided up as follows:—(1) An investigation into the efficiency obtainable by varying the mixture strength under normal conditions; (2) an investigation into the possibilities of reducing the mean mixture strength by means of working with a stratified charge; (3) experiments combining the use of a stratified charge with supercharging.

For the first series of tests a highly efficient single-cylinder vertical engine, direct coupled to a swinging field dynamometer, was used. The engine was provided with a Hopkinson optical indicator, and a carburetter in which the whole of the fuel was thoroughly vaporised, and in which the control of the fuel supply could be regulated with extreme nicety by means of a very fine needle valve. The results of these tests showed that so soon as the mixture strength was reduced to any substantial extent beyond that at which there was just sufficient air completely to combine with the whole of the fuel, incomplete combustion counteracted any gain in efficiency which might have resulted from the reduced flame temperature.

The second investigation was carried out on an old engine of 5in. stroke by 6in. bore, fitted with a new cylinder head, so arranged that a rich mixture of fuel and air and a large additional supply of pure air entered the combustion chamber at different points, and were so directed that, after entry, they would not completely mix, the air remaining over the piston with the mixture above it. The engine worked very nicely, and ran quite regularly with extremely weak combustible mixtures, but subsequent experiments on other engines proved that such results could not always be repeated.

For the purposes of the third set of tests, a special experimental engine was designed, using a system of supercharging generally similar to that devised by Sir D. Clerk, and was completed in 1915. This engine had a bore and stroke of 110 mm. and 140 mm. respectively, and was designed to run at a normal speed of 1500 revolutions per minute. The upper portion of the cylinder was quite normal and of the L-head type, with the inlet valve placed vertically over the exhaust valve, and operated by a push rod and overhead tappet. The piston, however, was formed in two parts, a plain head of aluminium carrying the piston rings, provided with a very short skirt furnished with a number of small oil grooves and a circular crosshead of considerably smaller diameter, the piston and crosshead being connected together by a hollow aluminium trunk. The crosshead portion of the piston, which carried the gudgeon pin, reciprocated in a white metal lined guide, which was carried in a separate casting interposed between the cylinder and the crank case.

The cylinder, which was very short, was spigoted into the separate casting carrying the crosshead guide, and the extension of the cylinder skirt was provided with a ring of ports uncovered by the piston at the bottom of its stroke. These ports were surrounded by a movable sleeve or shutter, so that they could be closed off at will. Surrounding the crosshead guide was an annular chamber having a minimum capacity of about 60 cubic inches, but the capacity could be varied at will over a wide range by means of hollow detachable plugs. A series of very light phosphor bronze flap valves admitted air to the chamber and acted as non-return valves during the compression stroke.

In its original form the cycle of operations was as follows:—Commencing at the beginning of the suction stroke, the piston, as it descended, drew from the carburetter a charge of petrol vapour and air of normal proportions. Towards the end of the stroke, the ports round the lower end of the cylinder were uncovered, and a charge of air compressed in the crosshead chamber to a pressure of about 12 lb. per square inch entered the cylinder. Almost simultaneously with the opening of the ports, the main inlet valve was closed. The supplementary air from the crosshead chamber raised the pressure of the cylinder contents to about 5 lb. per square inch above atmospheric pressure, and at the same time formed a layer above the piston, which remained in a more or less stratified condition throughout the compression stroke. During the upward stroke the contents of the cylinder were compressed, the combustible mixture remaining more or less at the top, and the pure air forming a layer over the piston. Meanwhile, another charge of air was drawn into the crosshead chamber. At the end of the suction stroke, the contents of the cylinder consisted of about 70 per cent. of combustible mixture of normal strength, namely, about 95 B.Th.U. per cubic foot, and about 30 per cent. of air, the former being concentrated more or less in the valve pocket, and in the neighbourhood of the sparking plug, and the latter forming a layer over the piston. The mean mixture density of the whole of the cylinder content was therefore only about 66 B.Th.U. per cubic foot, a density which, under ordinary conditions would not have been inflammable. On ignition, the combustible mixture in the neighbourhood of the sparking plug ignited with great rapidity, causing further violent turbulence in the combustion chamber, so that the air and the burning mixture were intimately mixed, but not until combustion was well under way.

Towards the end of the expansion stroke, the exhaust valve was opened in the usual manner and, shortly afterwards, the ports in the cylinder walls were again uncovered, and the cylinder swept through and partially scavenged by the second charge of air compressed in the crosshead chamber. This second charge again entered above the piston in a more or less stratified form, the gas

immediately above the piston being mostly air, while that nearer the top of the cylinder consisted mainly of exhaust products. On the upward stroke of the piston, the residual exhaust gases and part of the air were expelled through the exhaust, leaving the clearance space partially full of air. There was thus provided alternately a supercharge of air at the end of each suction stroke, and a scavenging charge at the end of each firing stroke, so that not only did the cylinder receive an additional charge of air over and above the charge drawn in from the carburetter, but a further supply of air was provided by the scavenging charge, which had the effect of replacing the residual exhaust gases in the combustion chamber with, at all events, a considerable proportion of pure air.

The main object aimed at, namely, the ability to work with a low mean mixture density, proved successful from the start, and it was found that the engine would run perfectly steadily with full supercharge when the charge admitted through the carburetter was rather on the weak side for normal running without a supercharge. In spite of the extra work done in pumping on the underside of the piston, both the brake horse-power and consumption were improved by about 5 per cent. when supercharging, the gain in indicated efficiency being nearly 10 per cent., which was in very close agreement with the theoretical gain. So long as the supercharge air was used only as a diluent and no attempt was made to increase the mean pressure beyond the increase due to the improved efficiency, all went well, but so soon as an attempt was made to raise the mean pressure to any substantial extent by enriching the mixture admitted through the carburetter, troubles began.

Although the flame temperature was lowered very considerably, as was proved by the gain in efficiency, the average temperature of the cycle was not apparently reduced to the extent that had been anticipated. When running normally with the most economical mixture, the brake mean pressure obtained was 106 lb. per square inch, corresponding to an indicated mean pressure of 121 lb. per square inch. When supercharging with the same mixture strength, the brake mean pressure rose to 112 lb. per square inch and the indicated mean pressure to 131.5 lb. per square inch. When, however, any attempt was made to increase the mean pressure by enriching the mixture, severe detonation was set up which soon resulted in pre-ignition.

The direct passage of air from the crosshead chamber to the cylinder was cut off by a diaphragm, and the air was forced to travel through an intercooler. This intercooler had, at this stage, no effect whatever. Next, in order to increase the effect of the scavenging charge, the exhaust valve was set to open some 66 deg. early, or 10 deg. earlier than before, when the detonation and pre-ignition became far worse, so much so, in fact, that the engine would not run for any length of time on the supercharge at all, even with the weakest mixtures. The indicator was next fitted on the intercooler, and it was found that when the exhaust valve opened 56 deg. early, the exhaust pressure in the cylinder at the moment when the ports were opened was slightly in excess of that in the intercooler, with the result that a very small quantity of exhaust gas passed out of the cylinder into the cooler and then back into the cylinder, followed by the air scavenge charge. When, however, the exhaust valve was set to open earlier, this did not occur, the air entering the cylinder straightway.

As the result of this experiment, the author came to the conclusion that the pure air scavenging charge, instead of flushing out and cooling the cylinder, tended to combine with the products of combustion, some of which were then not completely burned down to CO_2, and so connived at and even assisted in the continuance of combustion during the exhaust stroke. Now the effect of passing some of the products of combustion out of the cylinder, cooling them below the ignition temperature and then re-admitting them, was to prevent or, at all events, greatly reduce the after-burning, and also absorb the heat liberated by re-association.

The next experiment tried was to open the exhaust valve 52 deg. early, with which setting the pressure in the cylinder was approximately 36 lb. per square inch when the ports were opened, with the result that a very substantial proportion of exhaust products passed through the intercooler. With this setting it was found possible to increase the mean pressure to about 128 lb. per square inch on the brake, or 147.5 lb. per square inch indicated, without detonation. The experiment was tried of admitting a small proportion of cooled exhaust gas into the cylinder of the supercharging engine along with the fuel and air through the main inlet valve. This had the immediate effect of entirely eliminating all tendency to detonate, and it was found possible, by merely enriching the mixture, to raise the brake mean pressure to 140 lb. per square inch and the indicated to 159.5 lb. per square inch, which was the highest limit attainable, the whole of the supercharge air being then saturated with fuel. The quantity of exhaust gas admitted in this manner was extremely small, and yet its influence was remarkable. The exhaust cam was then set back to open the valve 66 deg. early, and a further test was made with cooled exhaust gas admitted through the carburetter, when it was found that the mean pressure could still be raised until the whole supercharge was saturated without there being trouble with detonation, though a somewhat greater quantity of exhaust gas was required under these conditions. The exhaust valve was next set to open at 48 deg. early, so that the pressure in the cylinder was still about 50 lb. per square inch when the ports were uncovered, and probably nearly one-third of the total exhaust products passed through the intercooler. In these circumstances the scavenging charge consisted mostly of cooled exhaust gas with a relatively small proportion of air, while the supercharge consisted mainly of air, but with a small proportion of cooled exhaust gas. With this setting, the engine behaved satisfactorily in every respect, and both objects were attained, for, on the one hand, the engine could be run on a low-temperature cycle, using the supercharge as a diluent, and so attain a very high thermal efficiency, and, on the other hand, the supercharge could, when desired, be used as an addition to the active working fluid, and a very high power output could be obtained, and, of course, any compromise was available between these two limits.

UNITED STATES PATENT DECISIONS.

BRITISH inventors often experience difficulty when they come to file applications for patents in the United States, owing to the different way in which inventions involving a combination of parts are considered there from the way in which they are viewed here. A case decided some years ago by the Acting Commissioner, often cited by the United States Patent Office, may explain some points in this connection. It is reported in 162 O.G. 540, and the appeal was taken before the District of Columbia Court, Report 36, App., D.C. 95.

The applicant claimed the various elements of a street-washing machine in combination. One of these elements was a nozzle, and it was admitted that that construction of nozzle was new. He asked for a patent for a combination which included the nozzle, but the Patent Office rejected the request, and their rejection was upheld on appeal. The decision held that if the appellant had made an improvement upon the nozzle of the prior art, he was entitled to be protected in the use of his invention, but he was certainly not entitled to a patent for a new combination merely because he had improved a single element of that combination. The invention claimed was for a combination of elements, and the suggestion was made that this combination effected the re-organisation of street-flushing machines by replacing separate flushing and sprinkling nozzles with an improved form of nozzle particularly adapted for flushing purposes and capable of use, in addition, as a sprinkler. The construction described in the claims disallowed was shown only to be for the same combination as had previously been used with the substitution of one nozzle for another, so that the inventor had not effected a new combination of old elements to produce a new and useful result. On this ground, he was not granted a patent for his combination. This decision is typical of United States practice, but differs from the practice of the Patent Office in this country. Here the inventor might have obtained a patent which included, say, a first claim to his improved nozzle, and a second claim to the combination in a particular machine, as described, of that improved nozzle. It is true that the Patent Office of recent years has been more careful in looking into the connecting link in these combination claims, particularly after the Law Officer's decision in the matter of Z's application, in which some claims were rejected because the elements of the combination were not necessarily only able to be used together, but parts could have been employed in other combinations. This case, however, was really decided on the question of there being one or more inventions contained in the particular specification, but it was not said even in that case that the Patent Office would have refused the grant of the alleged other combination claims if they had been presented in different applications.

The Patent Office tribunals are naturally not the only bodies that have to be considered in connection with the grant of patents, because actions are taken in the Law Courts. There it has been usual to hold that if one element of a combination is new, as in the Claim 1 referred to above, then if that element is included in another claim, as in the Claim 2 indicated, that claim is also valid.

HYDRO-ELECTRIC DEVELOPMENT IN CALIFORNIA.

A YEAR ago, when there was a shortage of power in California, the hydro-electric companies outlined a programme of development providing for an expenditure of 500,000,000 dols. in the State within the next ten years. Since then 300,000 horse-power has been added to the developed power of the State. Plants with a capacity of 250,000 horse-power are now under construction and are scheduled to be completed within the next ten months. Among the projects completed within the last twelve months are the Kerckoff plant of the San Joaquin Light and Power Corporation, which added 45,000 horse-power to the service of the San Joaquin farms, and also the natural gas-burning plant of the same company near McKittredge, with a capacity of 20,000 horse-power. An equivalent installation has been added to the Bakersfield plant, doubling its capacity.

In Southern California the Southern California Edison Company has added three new important units, all of them completed during 1921. The first to come into service was the 40,000 horse-power installation on the Kern River, which supplies energy over the Greenhorn Mountains to Vestal sub-station, where it connects with the Big Creek line. Soon after this plant was started up a third unit, with a capacity of 22,000 horse-power, was added to Big Creek plant No. 1. Big Creek No. 8 has recently been completed, with an initial capacity of 30,000 horse-power.

The Great Western Power Company completed its Cariboum plant early this year and thus increased the capacity of the system by 59,000 horse-power. The power is transmitted at a pressure of 165,000 volts, but even this record is to be broken by the Pacific Gas and Electric Company in its Pit River project, from which power is to be transmitted to San Francisco at 220,000 volts.

At the beginning of 1920 the total available horse-power in California power plants amounted to just about one million horse-power. This capacity has now been increased by 25 per cent., and there is sufficient construction work actually under way by California power companies to bring the output up to one and a-half million horse-power within another year.

IN an interesting article on "Electrolytic Lightning Arresters," appearing in the *Metropolitan-Vickers Gazette*, Mr. W. A. Coates states that it is not infrequently suggested that lightning arresters may be entirely dispensed with on very high voltage lines. A few systems already operate in this manner, but the majority of engineers who control systems at the highest pressure still prefer to install the most efficient protective apparatus available. Clearly, an induced charge of, say, 50,000 volts may cause serious trouble on a line operating at 20,000 volts normal, and be entirely harmless to a 110,000-volt line, as the insulators on the latter would not flash-over before 300,000 volts.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

The Fall in Pig Iron and Coke.

THE drop in pig iron announced last week becomes increasingly accentuated as smelters' anxiety to get the furnaces to work again increases and as they are assisted by lower prices for coke. The excessive cost of fuel and transport is the worst obstacle to the re-vitalisation of the trade. Furnace coke is now being offered at 22s. 6d. at the South Yorkshire ovens. If freights were still on a pre-war basis this might be an attractive figure, but as the coke costs about 10s. per ton to bring into this district, it would, on present figures, cost not under 31s. per ton delivered. It is declared that at this figure there is no possibility of profit to the smelters, who insist on a further reduction of from 5s. to 7s. 6d. per ton. There is certainly a considerable easing in the quoted rates for industrial fuel, and it is stated that the accumulation of smalls and varying conditions arising out of the situation of different coking plants are leading to considerable irregularities in the market. A report that prices had been further lowered to 18s. has been declared to be without foundation. The few additional blast-furnaces which have been re-commissioned are not finding it any easier to dispose of the balance of pig iron left over after the requirements of interdependent mills and foundries have been provided for. Prices have not crystallised yet. The continued holding off of consumers who are not under any necessity to buy in more than the smallest quantities is forcing down quotations. Some Derbyshire houses are asking upwards of 140s. at furnaces for foundry numbers, but in one case at least No. 3 was offered at 135s. Northamptonshire can be bought at 115s. and upwards. These prices show a further fall of 5s. per ton on last week's rates and make an aggregate recent drop of 35s. per ton. So far as consumers in the Midlands are concerned, Belgian iron has no longer any appreciable advantage, from a price point of view, but further south the balance is different, freightage being an important factor. It is stated that Belgian forge iron has been offered at an f.o.b. figure which works out at very little more than 100s. into works here. Smelters whose furnaces remain idle state that pig iron cannot be produced to sell at the prices named; it can only be considered a business proposition if the object aimed at is independent of the current market price. A Derbyshire concern whose furnaces were blown in because the furnace gases were required for the generation of power, has been obliged to stock nearly the whole of the output, orders being extremely scarce. The stocking of pig iron appears to be a very general experience. There is no indication of more furnaces being re-lighted in South Staffordshire. Within the past month a small number of blast-furnaces have been re-commissioned on the strength of substantial concessions in the price of coke. These re-adjustments of price have not been regularised, however, and if they had been smelters who sell their output on the open market, have very little encouragement to undertake the big expense of getting furnaces into blast again. The few furnaces that are able to enter into engagements for supplies in the near future have great difficulty in making any effective re-entry into the market.

Bars and the Nut and Bolt Trade.

Finished bars of Midland manufacture are now within possibility of attention on the part of the nut and bolt makers, and there is a growing likelihood of this industry witnessing an early revival. Inquiries for native iron are increasing, and in this connection it is notable that manufacturers have lately been expressing much dissatisfaction with the quality of the continental material, particularly on the score of the wastage entailed by its inability, for instance, to take the screw-thread satisfactorily in nut and bolt making. The quotation for Lancashire and Staffordshire nut and bolt bars is upheld at £16. The makers of high-grade bars continue to be fairly well employed on small orders. The price of marked bars remains unaltered at £20. Better inquiry is reported for galvanised corrugated sheets. There is practically no forward buying, but the mills operating are able to make tolerably full production on orders for immediate requirements. The trading community in the Birmingham district is settling down to business again after the distractions of the holiday season. There are indications of a more enterprising spirit, even though actual buying lags heavily. Such a demand is wanted as will enable industry to be operated economically for the levelling down of prices, which is the pre-requisite of a sound prosperity. The schooling of the past twelve months will surely be seen in an altered mentality on the part of all those who depend upon trade.

Midland Ironmasters' Paris Visit.

A large number of Midland ironmasters who took part in the Iron and Steel Institute visit to Paris a little over a week ago have this week expressed admiration for the numerous works they visited, which have been not only rebuilt since the Armistice, but, as a rule, have been modernised and enlarged for increased production. Some of the French works, it is stated here, have booked large orders for the supply of basic pig iron to English steel manufacturers at prices much below those prevailing in this country.

Steel Market Subsides.

The steel market has subsided after the recent attempts to re-animate it, and end the foreign ascendancy. Interest has during the week been quickened slightly by a report from Glasgow of a further reduction of £2 in sections. It was thought in some quarters that it might only be a Scottish move to give the shipbuilders a better chance of meeting foreign competition. In other quarters it was thought that a similar drop was to be expected south of the border, and Midland consumers have been holding off on the chance of this occurring. There has, however, been

no confirmation of the reduction, and I have it on the authority of Mr. George Hatton, managing director of the Earl of Dudley's Round Oak Works, that no reduction has taken place. The recent fall of Welsh billets to £7 10s. has brought a lot of new business, with the result that the firm quoting this figure is now asking another 10s. per ton. For large orders, however, it is believed this figure could be shaded. Continental prices show a tendency to harden, and this, together with the fact that early deliveries cannot be depended upon, makes the outlook for home producers certainly more hopeful as soon as buying is renewed on a more extensive scale. There is a steady buying of English steel bars at £13 10s. Those rolled from continental billets can be bought at as low as £11, but users who cannot afford to run risks take the higher quality products. Steel at its present price should be of some help to the sheet and tin-plate trades dependent on steel at a moderate price. There is a lot of cheap steel scrap to be bought. This material appears to have become very plentiful of late, and it is of great use to steelmakers in the production of cheap steel. There is a good deal of inquiry about for small tonnages, and the aggregate production shows a small increase.

Engineers and the "Churchill Bonuses."

By the time this letter appears the result of the negotiations on the engineering employers' demand to be set free from the anomalies of the notorious "Churchill bonuses" should be known. It is anticipated here that the demand will be conceded, and this week buyers have been waiting to see the effect on selling prices. It is a pity the question could not have been deliberated upon sooner, for the uncertainty which has prevailed throughout the engineering industry has added to the many difficulties and helped to cripple trade. Manufacturers attach more importance to the abolition of the 12½ per cent. True, it is but one of the items in the intricate problem confronting engineering firms, but there are cases in point in which it is the dividing line between putting more work into the shops or having to decline it. Until the matter was settled quotations could not be made, but it is evident that with the withdrawal of the award more work will be forthcoming locally, and it is equally evident that the rank and file of the workmen will be very glad to avail themselves of it.

The Late Capt. W. J. Kent.

I regret to have to record the death, which took place on Thursday last, of Engineer-Captain Walter J. Kent, who since 1919 has been the assistant managing director of Allen, Everitt and Sons, Limited, Kingston Metal Works, Smethwick. Captain Kent was well known in engineering circles in the Midlands, where he was held in high esteem. He was overseer for the Midland district for the Admiralty from 1906–9, and held the same appointment from 1915–19, when he retired. Among the many positions he had held was that of Engineer-Commander in charge of the mechanical training establishment at Chatham.

Dear Coal.

Though the price of best Cannock Chase deep house coal fixed by the Birmingham Coal Merchants' Association is still 60s. per ton, it is possible to buy at a slight reduction on that figure. Indeed, house coal is being sold at anything between 50s. and 60s. per ton, the exact price depending upon the quality. Factors state that they are paying coalmasters between 38s. and 42s. per ton. Customers have been advised by factors that prices are likely to harden rather than witness any reduction this winter. A leading Birmingham merchant says this week: "I cannot see any chance of a reduction coming about until we get a big reduction in miners' wages. An actual advance of 3½d. to men and 1½d. to boys per day has taken place this month. If the public is willing to burn works coal, there would not be the least difficulty in obtaining this fuel at about 42s. per ton, and this would help the trade, as a great many collieries are only now working three or four days per week on account of their inability to dispose of this quality." The trade slump and other factors have resulted in a big drop in the demand for coal, and it is being urged in some quarters that there should be a clearance of existing stocks at cut prices.

Black Country Firm's Venture.

John Freakley and Co., Dudley Port, have taken over, on a lease, the old slag tips at Acrefair, Denbighshire, and it is understood that they intend to work them for the tar-macadam process. Plant is to be put down, and it is expected that power will be supplied from a large works in the vicinity of the tips. At present the tip forms the only visible sign of the old British Iron Works, which were closed down a number of years ago.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER, Thursday.

Iron, Steel and Metals.

THERE is still a vague feeling in the market here that things are gradually getting better, although there is no definite evidence to this effect. Nevertheless, the feeling is better than nothing, and it will not be the first time such a thing has occurred, if the belief in improvement should bring improvement to pass. Sentiment in business is generally repudiated, but sentiment has a good deal to do with market movements, or at any rate with their beginnings. No doubt the apparent failure of the Irish negotiations has a depressing effect at the moment, but this is more evident on the Stock Exchange and the money market than in the industrial markets, and until hostilities are actually resumed in Ireland, many people will still believe in the possibility of an agreement.

Metals.

The movements in the market for standard copper have been insignificant for some time, although there was a slight recovery from the lowest prices touched. America appears to be doing what she can to support the market; but this kind of support from the chief producer of copper cannot be worth very much. A great deal is made of the reduction in the output, and no doubt this reduction, if it can be maintained, will tell very effectively on prices so soon as demand is restored; but no reduction and no manipulation can sustain a market in the absence of demand. Some people believe that a general improvement in the demand for copper is coming, but at present buyers seem to be acting very cautiously, and the enormous quantity of scrap on the market is a depressing influence. Scrap dealers generally say that they cannot find a market for old metals; whereas sellers of new metals complain that their outlet is curtailed by the tendency on the part of consumers to buy cheap scrap. One does not quite see how both these complaints can be true; they appear to destroy one another; but probably the real truth is that the whole market for metals is curtailed, and there is room for complaint, both by sellers of scrap and sellers of new metals. A further reduction in the price of brass locomotive tubes was announced, but it seems to have been contradicted for the present. Perhaps it is only contemplated, and it may be admitted that brass locomotive tubes might be sold at much lower rates than the official price of 1s. 0½d. per lb. Yellow metal rods are now at 8d. per lb., which seems quite a low rate when compared with the tube prices. There is nearly £30 difference between yellow metal rods and copper rods, whereas the difference between the two metal values is £18 per ton. This, again, is one of the curious anomalies of the present state of trade. All these anomalies must necessarily be attributed to the influence of combinations or associations on prices. The market for tin has been fairly steady of late, and as the price is now quite moderate, any further fall, if it should come, is not likely to be rapid. It is said that the American demand for tin-plates is improving, and this may perhaps be connected with the lower prices for tinned provisions. That these are falling rapidly is obvious, and by and by the demand for such goods will grow again and react on the demand for tin-plates. Experts in the tin market, however, do not believe that any serious rise in the metal is near at hand. It is, however, worth while just now to give the tin market close attention. The East appears to be shipping larger quantities, and this may mean that the stocks in that quarter are lessening. The engineering demand for tin in this country is still very poor, and there is no immediate prospect of an improvement, although this may come about in the course of the next few months. There is a prospect of a better demand for tin from the South Wales works during the remainder of this year, as with lower prices for steel sheets it is possible to make Welsh tin-plates at a practicable figure. Lead prices have kept fairly steady, but there is a growing feeling in the market that they are too high, and the actual demand seems to be declining. It is possible that the turn of lead for a fall in prices is near at hand. A more favourable market view of the future of spelter is now taken, but so far there has not been any very great change in the quotations here.

Pig Iron.

There is practically no demand in this market for forge pig iron, and it is to be assumed therefore that the Lancashire ironworks are not yet able to get much employment. For foundry iron there is always a demand, of course, but it seems to be dwindling a good deal of late, and one fears that the ironfoundries of Lancashire are unable to renew their orders for castings. This was anticipated some time ago, when it became clear that Lancashire would have to pay more for pig iron than the other districts, and it is partly the result of the increased railway carriage. The difference, for instance, between the old and the new Cleveland carriage is 9s. 6d. per ton on foundry iron, and it is a very considerable handicap. Two more Cleveland furnaces are to be blown in for foundry iron, and hence there will soon be more No. 3 on offer at £6 on trucks, although it is said that this price does not pay; but this will scarcely bring down the price of Derbyshire iron, which can already be bought here at £7 delivered, although some Derbyshire furnaces want as much as £7 on trucks. Very little buying of Scotch iron takes place here now, and this again is partly because of the excessive carriage.

Finished Material.

There has been very little change in the official prices for finished iron and steel, except that Lancashire bar iron has been reduced by £2 to £14 per ton, and best steel hoops by £3 to £17 5s. Unofficially, small steel sections are rather cheaper than they were. The reduction in bar iron is not sufficient to make much difference in the demand, and will certainly not check the tendency to buy the cheap continental makes, nor will it transfer much business from the bar steel trade.

Scrap.

It is said that there is a better feeling in regard to heavy wrought iron and heavy steel melting scrap, which two classes of material have been depressed for so long. There now is only a small demand here for foundry scrap, and with the exception of special lots suitable for use in the place of Scotch iron, the prices are inclined to sag. There is some cheaper Government cast scrap about, but the dealers are trying to maintain the price of broken machinery metal.

Proposed Hydro-Electric Power Scheme for Matlock.

In response to the request of the Urban District Council of Matlock, Messrs. Cramp and Frith, consulting engineers, have submitted their report on a proposed scheme for an electricity supply for that town. From the engineering aspect alone, the report states that sufficient current can be obtained from a hydro-electric plant on the river Derwent, the dry-weather flow of which is 8000 cubic feet per minute, but the cost of current would work out at about 8½d. per unit. This figure is arrived at by estimating the maximum load at 150 kilowatts. The cost of the plant and distribution mains is estimated at £13,000 and £10,000 respectively. In the former item £4000 is allowed for the construction of a dam across the river, to raise the water level by between 10ft. and 15ft., £1500 for flumes and tail races, £3000 for turbines, £2000 for buildings, £1500 for generators, and £1000 for switchgear. The running costs are put down at £4760, including £2000 for wages, salaries, stores, repairs, office expenses, &c., and £2760 for interest and sinking fund. The sale of 140,000 units per annum, at an average price of 6d. per unit, would yield £3500 per annum, showing a probable loss of £1260 per annum. As an alternative, Messrs. Cramp and Frith suggest the possibility of using and extending the existing power station for the tramways by installing a second engine and gas producer, and putting down storage batteries, at a cost of £18,500. The running costs of this plant, including anthracite at £5 per ton, are estimated at £4350, which gives a loss of £850 per annum, or puts the price of current up to 7½d. per unit.

Electric Dump Crane for Scrap.

A 12-ton electric Goliath travelling crane, with special features, has recently been built by Joseph Adamson and Co., Hyde, for the new steel works of John Summers and Sons, Limited. It has a span of 50ft. between the centres of the rails. The main girders are of the box pattern and the auxiliary girder on the longitudinal travelling motor side is of lattice construction, while the crane legs and carriages are also of box pattern, built up of steel sections and plates. The longitudinal travelling motion is designed for a travelling speed of 260ft. per minute, and is obtained by a 32 brake horse-power motor running at 400 revolutions per minute. It is fixed on a cast iron bed-plate carried above the crane platform in the centre of the span, and has a solenoid brake to prevent the crane moving when the circuit is opened. The lifting speed is 50ft. per minute, and the mechanism is operated by a 60 brake horse-power motor running at 540 revolutions per minute. It has an automatic magnetic brake to sustain the load when the current is switched off. The cross traverse motion at 80ft. per minute is driven by a 6 brake horse-power motor running at 630 revolutions per minute. The hoisting motion is controlled by contactor gear, with a master controller of the drum type, and is arranged for dynamic braking. The cross traverse and longitudinal travelling motions are controlled by plain series drum type crane controllers. The motors are of the series-wound reversing type, designed for a pressure of 220 volts. As the crane is intended for working in the open air, the cage is of steel, with sliding windows to give the operator a full view of the load. A steel resistance box, with hinged doors, is placed below the cage, which has ample room inside for the carrying out of any adjustments to the resistances.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is again a little more activity in the hematite pig iron trade from an industrial point of view. At Barrow one of the big furnaces has been put into operation, and it is expected that by Monday next a second will be at work following the settlement that has been arrived at between the mine owners and their men for a new basis of wages calculation on the sliding scale basis. There are now five furnaces in operation, the others, besides Barrow, being at Ulverston, Cleator Moor, Millom and Workington. These plants are mostly engaged in the turning out of special orders, for there is as yet not much business being done, the position being unchanged as regards consumers' demand for a lower level of prices. A further cut in prices can be expected at no distant date.

Iron Ore.

In the iron ore trade there is rather better employment in the mines to meet the demand for ore on local account, but there is no business being done outside the district, and at the mines short time is being worked. There have been no importations of foreign ore, but big stores are still held.

Steel.

The activity is maintained at the same level in the Workington district in the rail mills, but at Barrow there is as yet no sign of the steel-producing plant getting into operation. The Barrow Hoop Works continue pretty busy. The demand for steel is still very much in the background, and here, again, lower prices are looked for.

Shipbuilding and Engineering.

In the shipbuilding trade full time is now being worked in the joiners' shops, but there has been a setback by a strike of boilermakers, who on Friday last ceased operations. The engineering shops are working short time. The fitting out of the Australian liner is proceeding, but nothing is yet being done on the Cunard steamer Antonia which was launched some months ago. Two oil tankers are being fitted out.

SHEFFIELD.

(*From our own Correspondent.*)

No "Boom" Yet.

THE suggestion made to me a week ago regarding the new battle-cruisers seems to have been a little belated, the specifications having already been received, and, in all probability, the tenders sent in by now. I am told that the inner councils of the armament firms could go much further that that, if they cared to, in the direction of indicating the yards to which the vessels will be allocated; but the actual facts will be known any time now. A circumstance that lends itself to the belief that two of the warships will be built at the yards of Sheffield firms is the formation here of a very large dump of steel billets which, I am told, will consist of several thousands of tons.

These, it is supposed, are to be used as raw material for the making of heavy plates, forgings and castings, and will be conveyed into the armament works as required. Quite apart from the question of building a couple of the battle-cruisers, there is little doubt about Sheffield getting a very large share of the work of armour plate and heavy ordnance production, so that in any case the optimism publicly expressed recently by one or two directors of armament firms would appear to be finding early justification, for activity in the very heavy steel departments would find employment for a wide range of workers. Between that, however, and the absorption of the 30,000 or 40,000 people still unemployed in the Sheffield district there is a big difference, and those who may be looking to the building of the new ships as anything more than a partial remedy of the prevailing labour difficulties will be disappointed. It will help materially, but will not entirely cure. A good deal is being written "off the top" about wonderful trade booms, some of them bearing special reference to this area, but though I am quite hopeful of the future, and feel confident the worst has been seen, frankly, there appear to be no signs of anything that could be construed into an approaching "boom."

Where Things are Moving.

Reports continue to come to hand clearly indicating a trade improvement, and it appears that, following a reduction made by the Corporation in the price of electric current for power purposes, fully a dozen steel furnaces have been put into operation. Such things are all tending in one good direction. Then it is understood that Davy Brothers are erecting a large general rolling mill for Brown, Bayley's Steel Works, Limited, and that Hadfields, who, of course, are already known everywhere for their manganese points and crossings, are making important new rolling mill provision. Mr. T. H. Firth, head of the Brightside Foundry and Engineering Co., was speaking not too hopefully recently regarding the outlook for heavy engineers, though, as I will show in the next paragraph, his company is not so badly off for orders as a good many concerns are, and Davy Brothers, who are just now completing the new mill for the Tinsley Rolling Mills, Limited, seem to have some good work in hand for the construction of large boilers and hydraulic presses. One of the latter, I believe, is for a Belgian steel works, and the firm has, in the last few days, sent out two completed boilers, beside having another couple "on the stocks," so to speak. One Sheffield firm, I hear, has some nice orders to fulfil in the way of mining and other steel for South Africa, and it is said that the reconstruction work being pushed on with in France is resulting in very respectable business being placed in this district, where haste is being displayed by those firms making parts of machinery and plant for the new Bassett steel concern to get their contracts completed and the material dispatched to France, for it is expected that the works will be ready to commence operations before next year is very far advanced Other indications of trade improvement are provided by the increased activity at the railway goods yards—though, of course, part of it must be attributed to the traffic which the railways are succeeding in winning away from the road transport people.

Fine New Rolling Mill Plant.

But I want for a moment to revert, as promised, to the Brightside Foundry and Engineering Company, and also to Hadfields. The former has just completed for the latter a very fine 28in. reversing mill, comprising a set of cogging and finishing rolls. The mill, the company explains, is designed on the very latest practice, and is fitted up with all the essentials necessary for facilitating output. The electric driving of the mill is on the Ilgner system. The mill motor has an output of 3200 to 11,600 horse-power. The pinions are of forged steel with double helical machine-cut teeth and run in totally enclosed housings. The coupling between the mill motor and bottom pinion is of the Ortman type. Forged steel coupling spindles of the universal type are fitted between the pinion housings and cogging mill, also between the latter and the finishing mill. The top cogging roll is hydraulically balanced, and is raised and lowered by means of worm-driven screw-down gear actuated by a 40 horse-power electric motor. The housings for carrying both sets of rolls are of cast steel. The live roller gear on each side of the cogging and finishing mills is of the very latest design, all roller shaft bearings being of the ring lubrication type and the mitre wheels for driving the rollers running in oil. The live roller gear and skid gear are all driven through totally enclosed reduction gear. A set of hydraulic bloom shears of the up-cutting type, complete with hydraulic intensifier, is included in the plant. These shears are capable of cutting manganese steel 10in. square when hot, and give a total load of 1000 tons on the blades. A 60in. hot saw of the horizontal type is supplied for cutting the rolled bars to length after they have passed through the finishing mill. The Brightside Foundry has also completed a 30in. roll lathe for the Appleby Iron and Steel Company, capable of turning and necking rolls 40in. diameter by 14ft. long on the barrel, 24ft. long overall, weighing 40 tons. There is, too, in course of erection in the company's shops two pairs of electrically driven worm shears, capable of cutting cold steel 1¾in. square, a set of large De Bergue shears, and a 26in. cogging mill, complete with live roller gear, and a set of electrically driven horizontal shears for cutting blooms 6in. by 6in. hot, in connection with them. It will be seen from all this that the Brightside Foundry and Engineering Company's works are not exactly at a standstill.

Activity in Rolling Stock.

Clayton Wagons, Limited, the new associate company of Clayton and Shuttleworth, Limited, of Lincoln, has held its meeting of shareholders since last I wrote, and at the gathering Mr. P. W. Robson, the chairman, gave some interesting details of the company's operations since rolling stock building was commenced. There had been delivered, or were approaching completion, he said, 28 Pullman cars, 6 other coaches of that type had been completely rebuilt, 120 passenger coaches re-conditioned throughout, 1200 wagons built for abroad, 250 special wagons built for home railways, and over 2500 wagons repaired or rebuilt for home railways. Mr. Robson reminded shareholders that the company's future was bound up with that of the railways, and his belief is that railways are bound to remain the principal means of land transport. At the same time, Clayton Wagons directors are interested in the construction of such things as steam and petrol tractors, and as it is certain that road transport will find its place in the traffic world for the shorter journeys, the company is in a particularly favoured position. Anyhow, the profit on trading amounted to over £90,000—not at all a bad showing. The railways serving the Sheffield district, I know, are handling considerably more business than for a long time past, and there is evidence that at some of the goods yards staffs have been quite largely augmented. In the same ratio it seems the case that road transport enterprises are beginning to feel the pressure of severe competition.

Developments at Staveley.

The Staveley Coal and Iron Company, I notice, is coming into the market for money for important extensions the directors are carrying out. The company's present authorised share capital stands at two and a-half millions, and it is now proposed to bring it up to a round three millions. Of the 500,000 new £1 ordinary shares to be created, however, it is proposed to issue 463,773, and these will be offered at par to existing holders, in the proportion of one new for every five old, which, of course, should represent a small bonus, seeing that the quotation of the company's ordinaries is round 30s. The new money is required for sinkings to the black shale seam at Markham Colliery and at a pit near to the Devonshire Works, a new washery, further sulphuric acid chamber plant, an additional forty coke ovens with recovery plant—making 250—tar-macadam plant capable of dealing with about 2000 tons of blast-furnace slag per week, further extensions to the linking up of the overhead transmission line, making some 32 miles in all, plant for making pyridine and another for concentrating oleum, and further expenditure at Markham Main Colliery, Doncaster, the development of which has been withheld owing to the high cost of labour and materials. The directors add that in order to utilise to the fullest capacity the electric current available at the Devonshire Works, a plant is in course of erection for the electrolytic production of caustic soda and chlorine, and, with a view to securing an adequate supply of raw material, a controlling interest in a large area of salt land has been acquired in Cheshire on which a satisfactory supply of brine has been proved. It will thus be seen that the Staveley directors will be able to put the new money to be raised to useful and, no doubt, profitable purposes. The company made a profit for the twelve months to June 30th last, which, of course, included the whole of the national coal strike, of £232,740, the ordinary shareholders receive 10 per cent., tax free, for the year, and £47,278 is carried forward. A rather interesting point is that Mr. A. T. Cocking, who was formerly one of the managing directors of Kynochs, Limited, has joined the board in the capacity of technical director, so that his lifelong experience in the chemical industry may be applied to the company's new chemical plant.

Two Other Interesting Reports.

Another report of particular interest, as indicating industrial development in this part of the country, is that of the Sheepbridge Coal and Iron Company. In this case the net profits have fallen from £184,039 a year ago to £109,138, the company's business having suffered severely through diminution in trade and the national coal strike. The ironworks were fairly well employed until the commencement of the colliery trouble, but with the exception of the foundries and rolling mills, they have not resumed operations since the collieries re-started owing to the lack of trade and the drastic reductions in prices brought about by foreign competition. The extensions at the blast-furnaces and foundries are now well advanced, and the erection of workmen's houses at Langwith has made good progress. The lease of the company's ironstone mines at Frodingham, North Lincolnshire, expired in June, and was not renewed, but a new adjacent area, taken on lease, is to be opened out. Then there is Newton, Chambers and Co.'s subsidiary, viz., Thorncliffe Coal Distillation, Limited. This concern, which was separated from Newton, Chambers about eighteen months ago, was formed into a company with a capital of nearly half a million. The parent firm transferred to it its Rockingham and Thorncliffe coke oven and by-product works, and since then the new company has acquired the by-product plant of the Barnsley Main Colliery Company, which, as I mentioned in my letter last week, has recently installed a further battery of thirty-six coke ovens. In its first fifteen months of existence—the financial year ending on June 30th—Thorncliffe Coal Distillation, Limited, has made a net profit of £57,404. The ordinary capital is made up of 393,338 shilling shares—all held by shareholders in Newton, Chambers—amounting to a little less than £20,000, and the dividend to be paid for the fifteen months on this sum is no less than £15,175, so it will be seen that these fortunate shareholders receive the greater part of their investment money back in their first dividend.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

THE resuscitation of the staple industries of the North of England proceeds with disappointing slowness, and the outlook appears to be anything but encouraging. Operations at works have certainly shown some expansion during the past two or three weeks, but, on the most favourable estimate, it is to be feared that several more months must yet elapse before there can be anything like a return to the normal. In the iron and steel trade the position is one of uncertainty. Most of the works which have been re-started are only working intermittently, as orders come to hand. What manufacturers would like is to get some orders of decent magnitude on their books to ensure continuity of working; but until the position is more stabilised that seems too much to hope for. Buyers will only contract for prompt needs, and this all adds to the uncertainty. Moreover, foreign competition is very keen, and manufacturers experience great difficulty in securing any export business, even though they quote considerably below home prices. There is a little more activity in the shipbuilding and engineering trades, and at some establishments more men are being engaged. The coal trade shows no signs of revival. The conditions at the collieries vary considerably. Some are fairly well placed for the time being, whilst others have next to no orders in hand. The outlook is far from encouraging, and indeed the prospect is that there will be more idle days at the pits.

The Naval Contracts.

The Tyne shipbuilders and engineers are keen to secure the construction of one of the new £7,500,000 battleships. The firms tendering to construct the hull are Armstrong, Whitworth and Co., and Swan, Hunter and Wigham Richardson and Co., and the firms interested in the engines are Hawthorn, Leslie and Co., the Wallsend Slipway and Engineering Company and the Palmer Shipbuilding Company, Hebburn and Jarrow. Armstrong, Whitworth and Co. are also prepared to provide some of the armament for the new ships. This is the first occasion on which Swan, Hunter and Wigham Richardson have tendered for a battleship, but during the war they built the fast cruisers Comus and Coventry, and their record as builders of torpedo destroyers is well known. The Palmer Company has not tendered for the construction of the hulls of the new warships, owing to the fact that it has a number of merchant vessels to build; but it has sent in estimates for the supply of machinery for any ship of the new super-Dreadnought class that may be built.

Cleveland Iron Trade.

The Cleveland iron trade continues in a very depressed condition, and there is, unfortunately, little sign in the direction of a revival of the industry. The effort of the ironmasters to depress the price of raw materials by keeping their plant idle has not yet met with the success which they had hoped for, and they still adhere firmly to their resolution not to relight the furnaces under present conditions. Two furnaces have been put into operation this week, increasing the number in blast in the North of England to seventeen, but at least fifty more will need to go in to restore the industry to its normal activity. And whilst our furnaces stand idle, cheap foreign basic iron is pouring into the district in ever-increasing volume to feed the local steel works. Much of this basic iron has been bought at 87s. 6d. c.i.f., a price quite unapproachable by British makers. Indeed, 125s. is still named for prompt delivery of No. 3 Cleveland pig iron, though it can be bought in small quantities for October delivery at 120s. No. 4 foundry is freely offered at 119s. per ton, No. 4 forge and mottled at 117s. 6d., and white iron at 115s. per ton. The demand, however, is very slack, as most of the foundries are working short time or are altogether idle. Foreign trade, too, is dead, as our prices are far too high to compete with those of continental producers.

Hematite Pig Iron.

Owing to increased production of East Coast hematite, pig iron supply is more than ample to meet the requirements of users, and there are makers who are prepared to grant very substantial concessions to secure orders. Whilst some of them endeavour to maintain market quotations at something like the rates which have ruled for some time past, others are willing to sell mixed numbers, both for home use and for shipment abroad, at 130s., but even that price is more than continental buyers are prepared to pay. No. 1 quality is half a crown above the price of mixed numbers.

Iron-making Materials.

A few deliveries of foreign ore continue to be made under old contracts, but no new business is reported. The coke market is quite firm, and there is no present indication of any reduction in the price of blast-furnace coke below a figure of 35s. per ton at the ovens, which is regarded as excessive.

Manufactured Iron and Steel.

The position in the manufactured iron and steel trade has not undergone much change during the week. There is, however, a little more inquiry from abroad, and if British makers can adjust their prices they may be able to do big business, as the productive capacity of France, Belgium and Germany is gravely impaired, and both France and Belgium are suffering from labour troubles. It is reported that the galvanised sheet trade is improving slightly, but only through the use of cheap foreign spelter. This week iron bars have been reduced by £2 per ton, but quotations for other descriptions remain unchanged.

The Coal Trade.

The Northern coal market continues to drag along with very little variation, and little, if any, appearance of improvement can be detected. The competition for orders is very keen among local collieries, which, added to the still keener competition on the part of the various coalfields in this country and Scotland, renders the situation most anxious and difficult. There is, on the whole, a slightly better feeling with regard to the forward prospects of the coal export trade; but as yet the foundations for such hopes are comparatively slender, though there are a few more inquiries in hand, and a number of orders for small cargoes for prompt or early delivery are being booked. Still, the general tendency appears to be towards a slight easement in most directions. The collieries continue to make the most strenuous efforts to keep the present list of quotations intact, but here and there circumstances are too strong for them, and concessions are occasionally squeezed. The steam coal section seems fairly firm, especially in the case of D.C.B.'s, but

other classes can be discounted by as much as 2s. 6d. in odd instances. The prime and special classes of gas and bunkers are inclined to ease slightly, and cheaper lots have been purchased; but in the case of the cheaper brands a more rigid tone is observable, and there is a disposition to hold for the current quotations. The coke market continues quiet for foundry sorts, and in both patent oven and best beehive foundries discounts are workable, but for gas coke there is a brisk and growing inquiry, and the position is firm.

SCOTLAND.

(From our own Correspondent.)

Lead Miners' Strike Ended.

As a result of a vote taken last week, the strike at the lead mines at Wanlockhead is now at an end. The strike commenced in January of this year.

Shipping Depression.

The situation on the Clyde at present is unprecedented. Idle ships, empty wharves and unemployed seamen indicate an unparalleled state of affairs. On the Clyde over forty ships are out of commission, and cargoes cannot be secured. Upwards of seven hundred navigating officers are out of work, and are not in receipt of Government relief. Crews have been paid off wholesale. Furthermore, there is little prospect of an improvement this side of the New Year holidays. Almost all shipping companies are heavily hit, and one company is said to have every one of its boats laid up.

Return of Mr. Smillie.

While the full returns of the recent ballot of Lanarkshire miners for the election of officials are not yet completed, one or two nominations are definitely known. Among these is the election of Mr. Robert Smillie as president, Mr. Jas. C. Welsh as vice-president, and Mr. Duncan C. Braham secretary.

Advice to Steelworkers.

The depression at the steel works is most acute, and unemployment in Lanarkshire is growing at an alarming rate. Wholesale suspensions are reported among employees of the Steel Company of Scotland, while the Lanarkshire Steel and Ironworks have been closed down indefinitely, and are not likely to reopen this year. Colville and Sons, Limited, Motherwell, have issued a statement to their employees on the position, including the following remarks:—"The directors regret their inability to provide full employment at their various works. Even quoting below cost has not brought out sufficient work to employ more than a small part of the works, and prospects of continuing even present outputs are not bright. Costs are still too high to enable us to compete with foreign manufacturers, and the world seems unable to buy steel at the present range of prices. The directors will do their utmost to provide employment during this critical period, even at a loss to the company, and hope to receive the fullest assistance from employees to ensure the lowest possible cost of production."

Rush for Relief.

Applications for relief are pouring in from all parts of Motherwell and district, and include the highest paid classes of steel and iron workers. The situation in this district is aggravated by the suspensions at the collieries. Some collieries are closing down altogether. The National Union of Scottish Mine Workers has appointed a deputation to interview the Umpire under the Unemployment Insurance Act.

Pig Iron.

The situation in the pig iron trade is perhaps a shade brighter than in other branches of industry. In view of cheaper coke and adjustment of wages, makers are doing their utmost to name competitive prices. Some encouragement is taken from the growing scarcity and higher quotations for the foreign product.

Steel and Iron.

After what has already been said regarding unemployment, it is hardly necessary to add anything further concerning the steel and iron trades. Suffice it to say, that markets are absolutely flat and hardly the slightest indication of an improvement is apparent anywhere. Makers have reduced prices as far as possible, and considerable undercutting has also been reported without tangible results. The general situation could hardly be worse than at present.

Coal.

The coal trade is similarly placed. Fuel is plentiful, as regards large coal at least, but buyers are not being tempted by the reduced prices. Many consumers, of course, are out of the market meantime, but those still buying are only taking absolute necessities. The export trade does not realise expectations, and does not in any degree make up for the dearth of home business. Small stuffs are becoming a little scarce, and collieries now insist on round coal being taken with the former. Shipments are mostly coastwise, foreign clearances being few and of small bulk. Shipments for the week amounted to 163,098 tons, against 160,955 tons in the preceding week and 344,083 tons in the same week in 1913. The house coal trade is extremely slow for the season of the year. The best grade is selling at 2s. 5d. to 2s. 6d. per cwt. bag.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Steel Works Restarting.

It is very gratifying in these times when the problem of unemployment is so acute to find that large employers are doing their utmost to assist labour and relieve, to some extent, the existing distress. In addition to the re-commencement of work announced recently at the Ebbw Vale Steel Works, it is satisfactory to learn that Guest, Keen and Nettlefolds, Limited, have decided to start, as soon as practicable, part of their large works at Cardiff and at Dowlais. This will take place in the first week of October, and in order to get the works ready, repairing and other shifts will commence before that date. The directors naturally hope that the partial re-starting of the works will result in orders coming along more freely, so that the whole works will be able to resume operations before very long. It is expected that by the first week of next month work for several thousand men will have been found, and that the co-operation of the workers and a gradual adjustment of costs in contributory undertakings will enable the directors to tide over the present difficulties until such time as trade returns to its normal state. Sir Frederick Mills, the chairman of the Ebbw Vale Company, recently dealt with the whole position governing trade, and expressed the view that nothing but industry and determination can solve the present problem of unemployment. Prices will have to come down to the pre-war standard, and indeed even lower than those figures. He pointed out that they were making an attempt to get things going at Ebbw Vale again by taking the present prices that obtained. They were showing the best sympathy possible with the unemployed by incurring enormous costs in endeavouring to get work re-started. They were doing this because they felt someone had to make a start, and it was no use sitting down and looking at each other. A certain number of men at Ebbw Vale had re-started, and it depended upon the kind of work they did how quickly their fellow-workers followed them.

Colliery Tips.

The report has been current that German business men, with Hugo Stinnes at their head, have a scheme for securing large quantities of waste material at pitheads in order to extract their by-products, but while this so far is not confirmed, it is true that Guest, Keen and Nettlefold have inaugurated a plan for making use of the waste heaps at their Dowlais collieries. A subsidiary company, known as Tarmac South Wales, Limited, has been formed to manufacture and produce tarmac road-making material. The first truck of slag was put through the crushers at the end of last week, and it is estimated that when the full plant is installed about 4000 tons of the road-making material will be produced per week.

Miners' Wages.

The temporary agreement governing the coal industry terminates at the end of this month, and so also does the Government subsidy. This subvention of ten million pounds has not been exhausted, so it is understood that the unexhausted balance will go back to the Treasury. But even were this not the case, it is quite clear that the reduction in wages will be very severe, especially in South Wales. Mr. Vernon Hartshorn, the miners' leader, has expressed the view that they had not yet reached the worst stage in the wages of the miners, and he has described the agreement in operation as far worse than anything which the miners of Wales have yet worked under. The agreement was going to give them wages which, judged from the standpoint of purchasing power, would mean a lower standard of living than they had had in the lifetime of the oldest member of his audience. He added that they had had a 3s. per day reduction, and they would have a greater reduction next month, and they would be at the rock bottom the month following.

Working Hours at Docks.

Despite the quietness of market conditions and the inevitable irregularity in work at many collieries, returns regarding the coal export trade continue to display expansion, but it is an undeniable fact that there is severe congestion on the railways and at the docks owing to the excessive quantities of coal standing in trucks. The contention is being again put forward, and with much emphasis, that the conditions prevailing at Welsh ports regarding hours of work are very largely responsible for this congestion. It is maintained that the dock facilities are not equal to dealing with the coals coming down for shipment in the hours of work prevailing, viz., two shifts of eight hours each, and that one of the best methods for relieving congestion is for the trimmers and tippers to return to the pre-war conditions of working through the whole twenty-four hours. This reversion to pre-war conditions would also have the effect of assisting unemployment.

Colliery Combination.

Bad as the times are, generally speaking, in the coal industry, the tendency to combine interests continues and is probably enhanced by the necessity for such action. Guest, Keen and Nettlefolds, Limited, have taken steps to expand their interests, and have now made an offer to secure the Gwaun-cae-Gurwen Collieries, which form one of the most important anthracite undertakings in South Wales. The pits are situated in the Amman Valley, Carmarthenshire, and the property covers an area of about 5000 acres. The offer to the Gwaun-cae-Gurwen shareholders has been accepted by all the directors of the company with the exception of Sir Archibald Mitchelson, who is out of the country. Messrs. D. R. Llewellyn, H. Seymour Berry, Stephen O'Callaghan and Rowland G. Rees retain their seats on the board of the Gwaun-cae-Gurwen Company, and should any other director be asked to retire, he will receive, in addition to the directors' fees due, the sum of £1500. The terms of the offer provide that unless shareholders in the Gwaun-cae-Gurwen Company representing 90 per cent. of the issued capital agree to its acceptance by October 1st, Guest, Keen and Nettlefold have the option of withdrawing the offer. The capital of the Gwaun-cae-Gurwen Company is £229,770 in £1 ordinary shares, £16,640 in 7 per cent. £1 cumulative preference shares.

Current Business.

There is very little that is fresh to record in the state of the coal market, which is very quiet. The London and North-Western Railway is reported to be inviting tenders for supplies, but the inquiry from abroad is comparatively meagre and there is scarcely any class of steam coal which can be described as really steady, owing to the quantity of coal available. Best Admiralty large is generally quoted at about 32s. to 32s. 6d., but for prompt shipment buyers can shade this figure, while second Admiralties rule about 30s.

Latest News from the Provinces.

THE MIDLANDS AND STAFFORDSHIRE.

Further Reduction of Prices.

It became known on Birmingham Exchange on Wednesday that the Lancashire Bar Makers' Association had again taken the initiative in the process of deflation, reducing the price of marked bars from £20 to £18, and unmarked bars from £16 to £14 per ton. This revision, it is stated here, applies only to sales within the home radius and to the export trade. In the case of sales made in other districts the prices are conformable to those declared by the district associations. Accordingly, for South Staffordshire £16 is charged. On the occasion of the last reduction Staffordshire makers followed the lead set by Lancashire, and it is anticipated in Birmingham that prices will again follow those of Lancashire, and that a reduction of £2 in bars of local make will be announced within the next few days.

WALES AND ADJOINING COUNTIES.

Coal Inquiry.

An inquiry for about 50,000 to 60,000 tons of best Welsh steam coals for French naval account has been received by South Wales colliery companies. The coals are for delivery over the next three months.

Tin-plate Trade.

More mills are now in operation, among them being the Western Tin-plate Works, Messrs. Richard Thomas and Co.'s works at Llanelly, and the Pantyffynon Tin-plate Works, which have been idle for nearly a year. At present prices manufacturers are losing 2s. on every box of tin-plates. On Saturday last one of the largest consignments of tin-plates and galvanised sheets was cleared from Swansea for Shanghai, Singapore, Yokohama and other ports in China and Japan and the Straits Settlements, the quantity altogether being nearly 9000 tons. The outlook is certainly brighter, and more business for tin-plates is in the market. Firms anxious to re-start their works have booked orders, which in some cases barely cover cost, but still it means employment. If the demand continues there is a prospect that in a few weeks about 80 per cent. of the works will be at least partially in operation.

LAUNCHES AND TRIAL TRIPS.

PRAHOVA; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of La Premiere Société Nationale de Navigation Maritime, Roumania; dimensions, 372ft. by 51ft. by 24ft. 9in.; to carry, 6235 tons. Engines, triple-expansion, 24in., 39in. and 65½in. by 45in. stroke, pressure 180 lb.; constructed by the builders; launch, Friday, September 16th.

TEKOA; built by Earle's Shipbuilding and Engineering Company, Limited, to the order of Federal Steam Navigation Company, Limited; dimensions, 460ft. by 62ft. 6in. by 37ft. 9in.; to carry 11,600 tons deadweight. Engines, double-reduction geared turbines; steam supplied by five large boilers which are fitted with forced draught and superheaters and arranged for burning either coal or oil; launch, Tuesday, September 20th.

STEEL PRICES IN GERMANY.—The following average quotations for steel sections in Germany were given by the Department of Overseas Trade on the 14th inst. We give the equivalents in English money with the mark at 410 to the pound:—Plate, up to 2400 marks (about £6); hoops, 2250 marks (£5 10s.); hoops, cold rolled, 2650 marks (£6 10s.); rails, 2050 marks (£5); mining rails, 2050 marks (£5); wire rod, 2350 marks (£5 10s.); boiler plates, 2100 marks (£5); thin plates, 2600 marks (£6 5s.); black plates of middle sizes, 2600 marks (£6 5s.); stamping plates, double annealed, 6000 marks (£14 10s.).

ENGINEERING GOLFING SOCIETY.—The autumn meeting of the Engineering Golfing Society will be held at Sandy Lodge, on Tuesday, October 11th. In the morning there will be an 18-hole medal round for the "Hele-Shaw" scratch challenge cup and memento. Prizes also will be given in this round for the best and second best net scores in the first division for handicaps of 10 and under, and in the second division for handicaps of 11 and over; the best net scores for each nine holes, Nos. 1–9 and Nos. 10–18 under half handicap, fractions to count. In the afternoon there will be a round of foursomes—18-hole match play against bogey, under three-eighths of aggregate handicap—for the "Hadfield" challenge cups. Mementoes and second prizes will be given. Players may choose their partners (not necessarily in the same division) for the foursomes, and should indicate this when entering; otherwise partners will be balloted for by the sub-committee. Couples and starting times for the morning round will be determined by ballot. Members will be advised as to the result of the draw and times of starting. It is hoped to start the competition not later than 10 a.m. Entries close by first post on Wednesday, October 5th. Further particulars may be obtained from the Hon. Secretary, Mr. Walter L. Mansergh, 5, Victoria-street, Westminster, S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	—
[1] Spanish	28/-
[2] N. African	28/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	28/- to 29/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—[3]		
Hematite	7 15 0	—
No. 1 Foundry	8 5 0	—
No. 3 ,,	8 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	6 10 0	6 10 0
No. 1	6 12 6	6 12 6
Cleveland—		
No. 1	—	—
Silicious Iron	—	—
No. 3 G.M.B.	6 0 0	6 0 0
No. 4 Foundry	5 19 0	5 19 0
No. 4 Forge	5 17 6	5 17 6
Mottled	5 17 6	5 17 6
White	5 15 0	5 15 0
MIDLANDS.		
Staffs.—		
All-mine (Cold Blast)	17 0 0 to 17 7 6	
Part Mine Forge	*None offering.*	
,, Foundry No. 3	,,	
Northampton *(Delivered Midlands).*—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	6 10 0	
,, Forge	*Nominal.*	
Derbyshire [4] *(All nominal).*—		
No. 3 Foundry	6 10 0 to 6 15 0	
Forge	6 0 0	
Lincolnshire—		
Basic	*Uncertain.*	
Foundry	,,	
Forge	,,	
N.W. COAST—[4]		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	7 15 0	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	14 0 0	—
Best ,,	17 0 0	—
N.E. COAST—		
Common Bars	14 0 0	—
Marked ,,	18 0 0	—
Tees	14 10 0	—
LANCS.—		
Crown Bars	14 0 0	—
Hoops	20 5 0	20 0 0
S. YORKS.—		
Crown Bars	16 0 0	—
Best ,,	17 0 0	—
Hoops	17 5 0	—
MIDLANDS—		
Marked Bars (Staffs.)	20 0 0	—
Crown Bars	16 0 0	—
Nut and Bolt Bars	15 10 0 to 16 0 0	
Black Sheets (dbls. nom.)	17 0 0 to 17 10 0	
Galv. Sheets, 24 W.G. (f.o.b. L'pool, or equal)	20 0 0 to 22 0 0	
Gas Tube Strip	17 10 0	

STEEL.

	Home.[5] £ s. d.	Export.[7] £ s. d.
SCOTLAND—[5]		
Boiler Plates	19 0 0	—
Ship Plates ¾in. and up	14 0 0	—
Sections	13 10 0	—
Steel Sheets 5/16in. to ¾in.	15 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	24 0 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	14 0 0	14 0 0
Angles	13 10 0	13 10 0
Boiler Plates	19 0 0	19 0 0
Joists	13 10 0	13 10 0
Heavy Rails	14 0 0	—
Fish-plates	19 0 0	—
Channels	14 10 0	—
Hard Billets	11 0 0	—
Soft Billets	9 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	14 0 0	—
Light ,,	16 0 0 to 18 0 0	
Billets	13 0 0	—
Ship Plates	14 0 0	—
Boiler ,,	20 0 0	—
MANCHESTER *(Prices irregular and uncertain, unchanged)*—		
[6] Bars (Round)	12 0 0 to 14 0 0	
[6] ,, (others)	13 0 0 to 15 0 0	
Hoops (Best)	17 5 0	17 0 0
,, (Soft Steel)	14 5 0	14 0 0
Plates	14 0 0	—
,, (Lancs. Boiler)	20 0 0	—
SHEFFIELD—		
Siemens Acid Billets	16 0 0	—
Bessemer Billets	15 10 0	—
Hard Basic	13 0 0	—
Soft ,,	8 0 0 to 10 0 0	
Hoops	14 5 0	—
Soft Wire Rods	13 15 0	—
MIDLANDS—		
Small Rolled Bars	11 10 0 to 13 0 0	
Bessemer Billets and Sheet Bars	7 10 0 to 8 10 0	
[2] Hoops	14 0 0	—
Tube Strip	12 0 0 to 13 0 0	
Angles and Joists	13 10 0	—
Tees	14 10 0	—
Bridge and Tank Plates	14 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	21/6 to 23/-
Block Tin (cash)	155 10 0
,, (three months)	157 15 0
Copper (cash)	67 15 0
,, (three months)	68 10 0
Spanish Lead (cash)	22 15 0
,, (three months)	22 12 6
Spelter (cash)	25 0 0
,, (three months)	25 10 0
MANCHESTER—	
[9] Copper, Best Selected Ingots	70 0 0
,, Electrolytic	73 10 0
[10] ,, Strong Sheets	103 0 0
,, Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 0½
,, Condenser	0 1 4½
Lead, English	24 5 0
,, Foreign	23 5 0

(Metal prices practically unchanged).

FERRO ALLOYS.

(All prices now nominal).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/6 to 1/8 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£36	12/-
,, 6 p.c. to 8 p.c. ,,	£34	12/-
,, 8 p.c. to 10 p.c. ,,	£34	12/-
,, Specially Refined		
Max. 2 p.c. carbon	£79	28/-
,, 1 p.c. ,,	£94	32/-
,, 0·75 p.c. carbon	£110	41/-
,, carbon free	2/8 per lb.	
Metallic Chromium	5/6 per lb.	
Ferro Manganese (per ton)	£18 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 0 0 scale 6/- per unit	
,, Vanadium	22/- per lb.	
,, Molybdenum	9/- per lb.	
,, Titanium (carbon free)	1/6 per lb.	
Nickel (per ton)	£190	
Cobalt	14/6 per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	24/6
,, ,, Ell	25/-
,, ,, Splint	26/6 to 30/-
,, ,, Trebles	30/-
,, ,, Doubles	27/6
,, ,, Singles	25/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	24/6
,, ,, Splint	26/6
,, ,, Trebles	29/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	21/- to 25/-
Screened Navigation	33/-
Trebles	29/-
Doubles	26/-
Singles	24/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	22/-
Secondary Steam	21/-
Trebles	30/-
Doubles	27/-
Singles	25/-

ENGLAND.

[11] N.W. COAST—	
Steams	44/-
Household	56/6 to 60/-
Coke	37/6 to 42/6
NORTHUMBERLAND—	
Best Steams	27/6 to 30/-
Second Steams	25/- to 27/-
Steam Smalls	15/- to 17/6
Unscreened	22/6 to 27/-
Household	30/- to 35/-
DURHAM—	
Best Gas	29/-
Second	25/- to 27/6
Household	30/- to 35/-
Foundry Coke	45/- to 55/-
SHEFFIELD—[12]	
S. Yorks. Best Steam Hards	33/2 to 33/8
Derbyshire Hards	32/8 to 33/2
Seconds	31/8 to 32/2
Cobbles	31/8 to 32/2
Nuts	31/2 to 32/2
Washed Smalls	28/8 to 30/2
Best Hard Slacks	20/- to 25/-
Seconds ,,	20/- to 23/-
Soft Nutty ,,	20/- to 25/-
Pea ,,	18/- to 22/-
Small ,,	15/- to 18/-
House, Branch	37/2 to 37/8
,, Best Silkstone	33/8 to 34/2
Blast Furnace Coke	25/- to 30/-

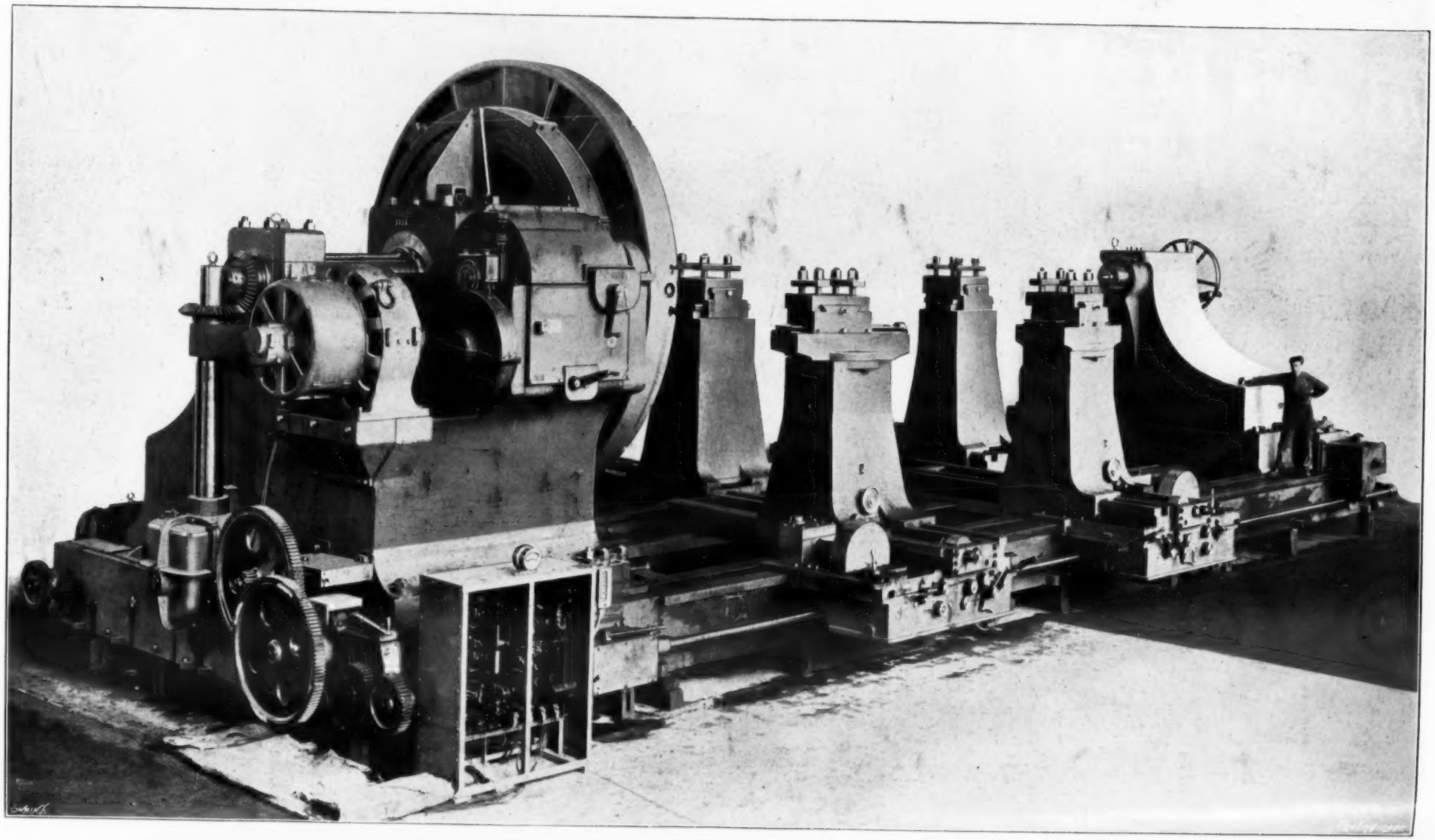
[13] SOUTH WALES.

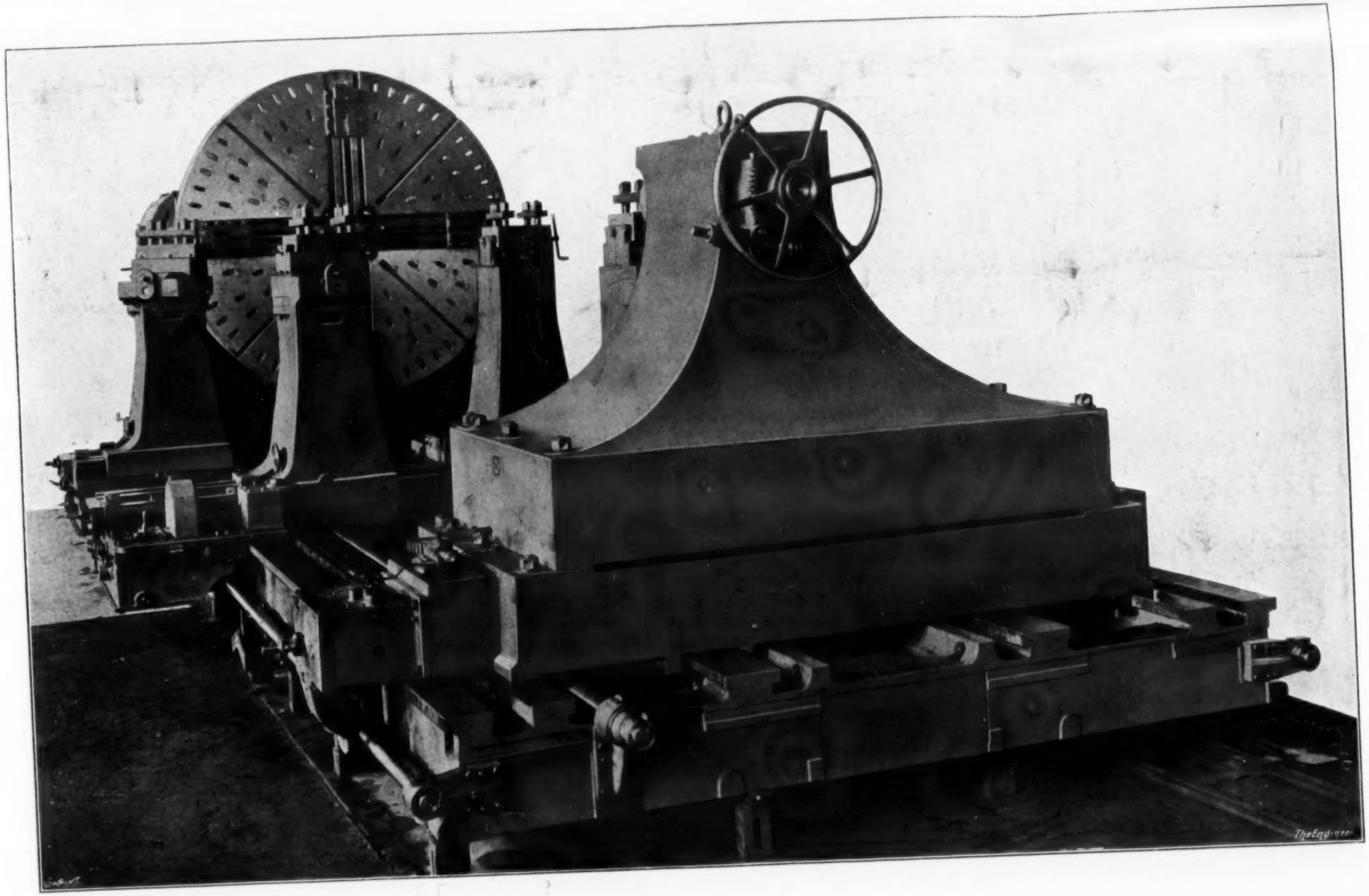
CARDIFF—	
Steam Coals:	
Best Smokeless Large	31/6 to 32/6
Second ,, ,,	30/- to 31/-
Best Dry Large	30/- to 31/-
Ordinary Dry Large	27/6 to 30/-
Best Black Vein Large	28/- to 29/-
Western Valley ,,	27/6 to 28/-
Best Eastern Valley Large	27/- to 28/-
Ordinary ,, ,,	25/- to 27/-
Best Steam Smalls	19/- to 19/6
Ordinary ,,	9/- to 17/-
Washed Nuts	32/6 to 35/-
No. 3 Rhondda Large	30/- to 35/-
,, ,, Smalls	22/6 to 25/-
No. 2 ,, Large	24/- to 26/-
,, ,, Through	20/- to 24/-
,, ,, Smalls	16/- to 17/-
Coke (export)	60/- to 62/6
Patent Fuel	30/- to 32/6
Pitwood (ex ship)	30/- to 32/6
SWANSEA—	
Anthracite Coals:	
Best Large	52/6 to 55/
Seconds	50/- to 52/6
Red Vein	40/- to 45/-
Big Vein	52/6 to 55/-
Machine-made Cobbles	70/- to 72/6
Nuts	70/- to 72/6
Beans	57/6 to 60/-
Peas	40/- to 42/6
Breaker Duff	12/6 to 15/-
Rubbly Culm	18/- to 20/-
Steam Coals:	
Large	32/6 to 35/-
Seconds	30/- to 32/6
Smalls	15/- to 17/6
Cargo Through	22/6 to 25/-

[1] Delivered. [2] Net Makers' works. [3] At furnaces. [4] Delivered Sheffield. [5] Glasgow, Lanarkshire and Ayrshire. [6] Home Prices—All delivered Glasgow Station.
[7] Export Prices—F.O.B. Glasgow. [8] Prices represent the real market before the *official* change was made. [9] These prices are practically alike now.
[10] Sheets reduced while other prices are advancing. [11] Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export.
[12] For inland sales. [13] Per ton f.o.b.

111-INCH—123-INCH SLIDING, SURFACING AND SCREW-CUTTING LATHE

THOMAS SHANKS AND CO., JOHNSTONE, ENGINEERS





French Engineering Notes.

(From our Correspondent in Paris.)

Trade Prospects.

THE recent symptoms of a slight recovery in trade have not stopped the further depreciation of the franc, which has given rise to a good deal of uneasiness at a time when things seemed to be on the point of taking a turn for the better. If all the undertakings in contemplation could be put in hand there would be no lack of employment, but the work cannot be done without capital, and as no money is coming into industrial enterprise a large number of big contracts for public undertakings are being held in abeyance. The situation is further aggravated by the prevailing idea that manufacturing costs are out of all proportion to the purchasing value of money, or, in other words, that wages are generally too high, and that consumers cannot be induced to buy more freely until there is an appreciable reduction in selling prices. While commodities have become cheaper, there is no corresponding reduction in wages. Doubtless the wages would remain untouched for the time being if it were possible to secure relief from the heavy fiscal charges that burden industry, but as the State will not consent to any alleviation, it only remains for the men to make some sacrifice in order to improve the industrial situation and ultimately better their own position as well. Having become accustomed to a new standard of living, with high wages for less work, the men are holding on to all they have gained. Had they fulfilled their term of the contract by ensuring that there would be no reduction of output as the result of the eight hours' day, it is probable that employers would not be under the necessity of bring down wages. An increased production at a lower cost would place French manufacturers in a much better position for securing foreign business, and that, at the same time, would have undermined the plea for protection which has had the effect of shutting this country out of export markets. No one is satisfied with the present fiscal policy, and the only way by which makers can see the possibility of reviving trade is to reduce wages to a normal level and cheapen production. How great are the obstacles in the way of this reduction is observable in the struggle going on in the Nord, where the strike was so complete during the past week that all industrial activity in the Roubaix and Tourcoing districts was completely suspended. The severity of the struggle is due entirely to the communistic element. The main body of workers has long seen the hopelessness of holding out against a reduction, and the leaders have this week endeavoured to submit the dispute to arbitration, but the textile firms refuse absolutely to compromise. They urge that the industry cannot possibly continue to exist in face of the present competition unless the men accept wage reductions.

German Negotiations.

Although the putting in hand of the large number of public works as soon as funds are available would no doubt result in considerable industrial activity, they would not bring immediate prosperity to the country, beyond providing it with the means of further developing and cheapening production in the future. Such activity does not introduce foreign money, and therefore cannot help to improve the rate of exchange, without which foreign commercial exchanges are seriously restricted. With her huge mineral and colonial resources, France is capable of developing a considerable export business if only she were not hampered by the fiscal barriers put up by other countries, principally in retaliation against the French initiative. There is now scarcely a market from which French manufacturers are not practically excluded, and as the national welfare depends upon a large export trade and the bringing of foreign money into the country, manufacturers are for the most part regarding with favour the proposal to enter into some economical arrangement with Germany. Already German machinery and other goods are being offered in France, despite the crushing import duties which it was expected would have shut out German products altogether. The idea is now gaining ground that Germany should participate more largely in the work of reparation, and that certain facilities should be offered for the importation into France of goods that do not compete directly with home manufacturers, in return for which everything will be done to encourage the sale of French goods in Germany. There is quite an important section of the industrial class which believes that herein lies a solution of the difficulty. As France is largely shut out from countries where the exchange is against her, she hopes to do business with Germany and other countries where the monetary depreciation is greater than her own.

Railway Disaster.

Although excessive speed was the primary cause of the terrible accident to the Strasburg express at Les Echets, it has not been found possible to ascertain exactly the conditions under which the disaster took place. It is supposed that the driver, realising his error, applied the brakes too suddenly for such a high speed, and the locomotive left the rails. The speed is officially limited to 20 kiloms. per hour, but the speed indicator on the engine appears to have registered 97 kiloms. at the time of the accident. As was the case with the recent accident on the Nord Railway, the Strasburg express was, it is stated, composed of light and heavy coaches, which may have aggravated the disaster. The Minister of Public Works insisted some time ago on express trains being made up with bogie coaches, but few companies are yet sufficiently equipped with such vehicles to follow that rule.

Public Works.

The programme of public works to be carried out with the aid of the Paris Municipal Loan is being put into execution. The first part of the programme provides for maintenance works that were suspended during the war and for the construction of cheap dwellings and for the bringing of fresh supplies of water to Paris from the Durtain and the Voulzie. The volume of water available from these new sources will be 90,000 cubic metres. The expenditure upon these undertakings is estimated at 128 million francs.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

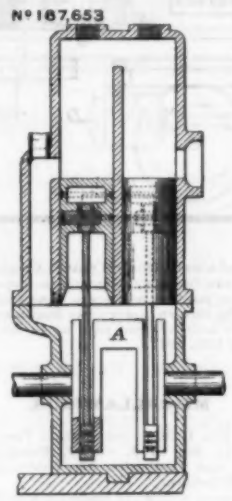
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

167,653. June 24th, 1920.—TWIN-CYLINDER TWO-STROKE ENGINES, T. D. Kelley, 11, Denmark Villas, Hove.

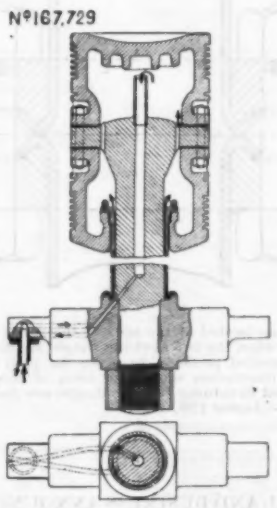
THE principal claim in this specification is for the use of an



idle crank pin A, set opposite to the working cranks, for balancing purposes.—*August 18th*, 1921.

167,729. May 25th, 1920.—PISTON COOLING, V. Mickelsen and F. E. Rebbeck, of Harland and Wolff, Limited, Belfast.

In order to protect the piston-rods of double-acting internal combustion engines from the effect of the hot products of combustion the inventors encase the rod with a sleeve and circulate

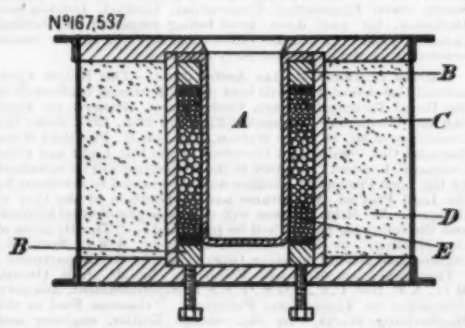


water through a space between the sleeve and the rod. Arrangements are made at the crosshead end to accommodate expansion and contraction of the sleeve. The cooling water is admitted at the crosshead in the usual manner and circulates as shown by the arrows.—*August 18th*, 1921.

ELECTRIC FURNACES.

167,537. April 31st, 1920.—IMPROVEMENTS IN ELECTRIC RESISTANCE FURNACES, Arthur Imbery, of 14, St. Albans-avenue, Halifax, Yorkshire.

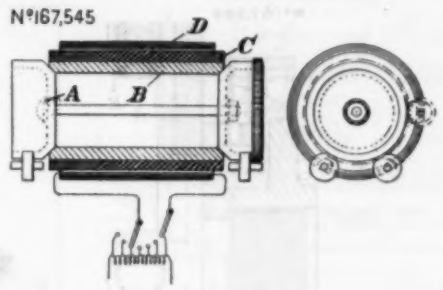
The crucible or muffle A which is made of moulded or refrac-



tory material, such as carborundum or aloxite is fixed between two annular graphite terminal plates B. Surrounding the crucible or muffle is a refractory cylinder C, and surrounding the latter is a packing of refractory material D of good heat insulating qualities. The space between the external wall of the muffle or crucible A and the refractory cylinder C is filled with spheres E of graphite or other suitable material of varying diameter, and the pressure upon these spheres can be regulated by means of the set screws. The electrical resistance of the heating circuit can therefore readily be adjusted to meet any particular condition of heating.—*August 2nd*, 1921.

167,545. February 7th, 1921.—IMPROVEMENTS IN AND RELATING TO ELECTRIC FURNACES, The British Thomson-Houston Company, of 83, Cannon-street, and George James Ralph, of Albert House, Albert-street, Rugby.

According to this invention it is proposed to utilise an induction type of furnace for heating articles, either for the purpose of tempering them or of coating them with certain substances. The revolving ends A of the furnace are removable for charging

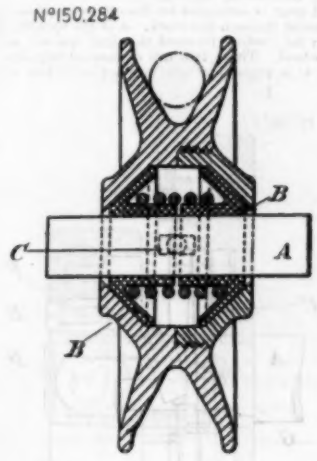


purposes. Surrounding the cylindrical wall B is a layer C of good heat-insulating material, and near this material is a fixed coil D. Alternating current is supplied to this coil, and the wall B acts as a short-circuited secondary, with the result that the rotating cylinder is rapidly heated to any desired temperature.—*August 5th*, 1921.

ELECTRIC TRACTION.

150,284. August 21st, 1919.—IMPROVEMENTS IN TROLLEY WHEELS FOR OVERHEAD ELECTRIC TRACTION, Jules Jassaud, of 17, Boulevard Gallieni, Neuilly-Plaisance, Department of the Seine, France.

On the spindle A are two truncated cones B with their larger bases facing each other. Angular displacement of the cones is prevented by a pin engaging in the slot C. The cones are free to move longitudinally in relation to the fixed spindle under the action of a spring mounted between them. Under the pressure

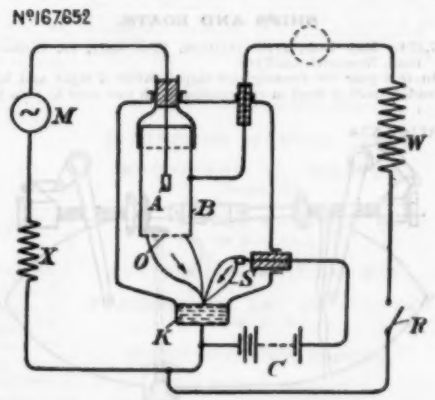


of the line wire in the groove of the trolley and by reason of the movement of the vehicle, the trolley wheel rotates in the usual manner and consequently revolves around the two fixed cones B, the wear being automatically compensated by the longitudinal displacement of the cones under the action of the spring.—*August 18th*, 1921.

SWITCHGEAR.

167,652. August 18th, 1921.—IMPROVEMENTS IN HEAVY CURRENT RELAYS, *Gleichrichter Aktiengesellschaft, of Glarus, Switzerland.*

This invention consists in surrounding the anode A of a metal vapour rectifier (connected in a circuit to be controlled) with a metal casing B, which is connected through a resistance W to



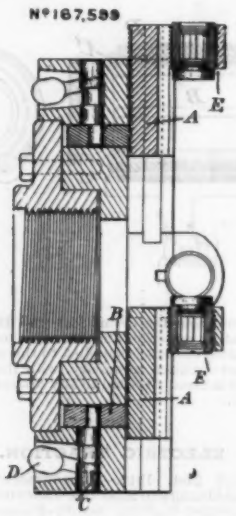
the cathode K. The metal covering B is provided with a sieve covering at O. An auxiliary source of current C maintains an auxiliary arc at S for the excitation of the cathode. The source of alternating current M, the resistance X, anode A, and cathode K constitute the circuit to be controlled. When the switch R

is open and the auxiliary arc is struck at S, another arc is formed between O and K, and this arc is fed with uni-directional current impulses. When, however, the switch R is closed, the flow of current in the left-hand circuit containing the generator M and resistance X is instantly stopped. The theory of the apparatus is described.—*August 18th*, 1921.

MACHINE TOOLS AND SHOP APPLIANCES.

167,599. May 15th, 1920.—INDEPENDENT JAW CHUCKS, Charles Taylor (Birmingham), Limited, and G. B. Taylor, Bartholomew-street, Birmingham.

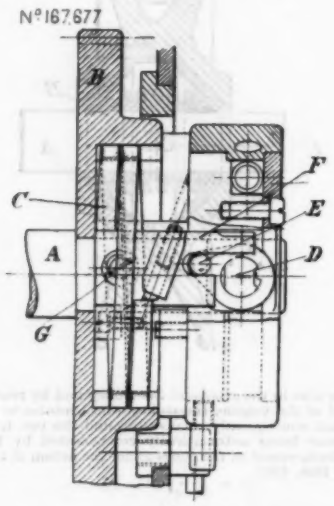
In this chuck the carriers A A slide in grooves in the body and are fixed by keys B B engaging with teeth on their backs. The keys are operated by the small excentrics C, which have thumb



pieces D at the back of the chuck. When the carriers have been roughly adjusted to the work a grip is effected by turning the screws E, which have loose gripping faces.—*August 18th*, 1921.

167,677. July 29th, 1920.—FEED GEAR FOR DRILLING MACHINES, Smith and Coventry, Limited, and J. H. Wright, Grosley Ironworks, Salford.

This feed gear is arranged to disengage itself as soon as the drill has passed through the work. A is the spindle of the usual rack pinion for feeding forward the drill spindle, and B is the feed gear wheel. These two are connected together when the coil spring C is expanded into contact with the recess in the

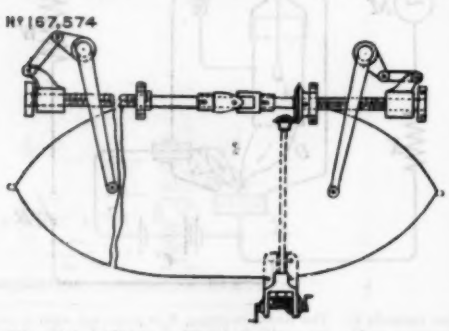


wheel. In its relaxed state the spring is clear of the recess. The spring is expanded by twisting the handle D, when the crank E rocks the lever F about the pivot G and presses on the end of the spring C. The driving effort keeps the spring expanded, but when the drill passes through the work and resistance to movement of the spindle A ceases, the spring contracts and releases the feed.—*August 18th*, 1921.

SHIPS AND BOATS.

167,574. May 10th, 1920.—DAVITS, T. J. Carr, 78, Welbeck-road, Newcastle-on-Tyne.

In this gear for turning out ships' davits a right and left-threaded shaft is used in conjunction with two nuts to turn the

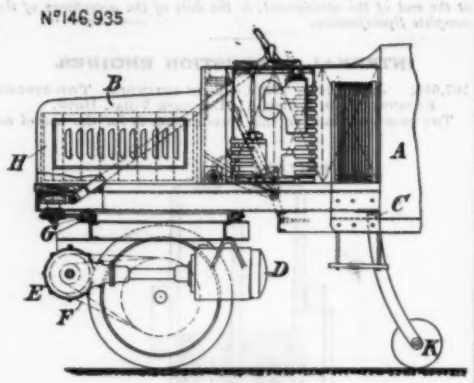


davits by means of the links and levers shown. Alternative methods of driving the screw shaft are described.—*August 10th*, 1921.

MOTOR CARS AND ROAD TRAFFIC.

146,935. July 8th, 1919.—IMPROVEMENTS IN AND RELATING TO ELECTRICALLY OPERATED MOTOR VEHICLES, Hansa Lloyd Werke Aktiengesellschaft, of Bremen 11, Germany.

The rear part A of the vehicle is coupled with the front part B by means of a fastening C. The front part consists of a driving wheel frame which contains a motor D, a gear E, and two chain drives F, and is pivotally connected by means of a ball bearing G with a car frame, which carries a battery H, a steering device,

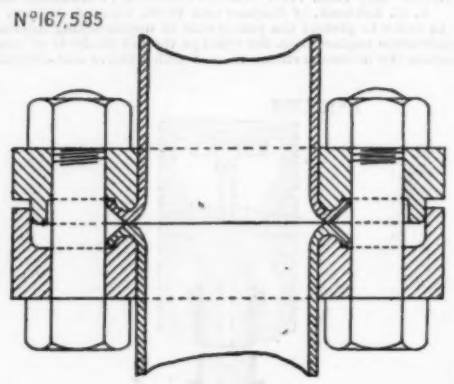


a driver's seat, and also the control gear. A supporting wheel K is provided, and can be brought out of an inoperative position into the travelling position as shown, thus enabling the front portion to travel by its own power away from a rear part in order to be coupled to another rear part or to have its batteries charged.—*August 15th*, 1921.

MISCELLANEOUS.

167,585. May 12th, 1920.—PIPE JOINTS, Cammell Laird and Co., Limited; Sir G. J. Carter, Brackenwood, Higher Bebington; and F. Davies, 18, Westbank-road, Devonshire Park, Birkenhead.

In this specification a claim is made for a method of jointing pipes which consists in so turning over and shaping the ends of the pipes to be jointed as to form flanges thereon, one or both of which are characterised by the provision of a narrow annular



jointing surface located at the apex of the flange cross section and adapted, when the two abutting flanges are drawn together by axially directed pressure, to make the joint between the pipes. The illustration shows the form of the joint. The appliances used in turning over the flanges are described in the specification.—*August 12th*, 1921.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. FRANK H. BRUNT, M. Inst. C.E., informs us that he has recently removed from 100 to 121, Victoria-street, S.W. 1, and that his telephone number is Victoria 8477.

THE next annual dinner for past and present pupils of Mr. G. P. Knowles will be held at the Trocadero Restaurant on Friday, October 14th next. Application for tickets should be made to Mr. Knowles at 39, Victoria-street, Westminster, S.W. 1.

CONTRACTS.—We are advised that the Lyttelton Harbour Board of New Zealand has accepted a tender from the Wellman Smith Owen Engineering Corporation, Limited, London and Darlaston, for two 5-ton level luffing cranes of the Jardine patented type. This order follows one for four similar cranes ordered from the same firm early this year.

BRITISH COMMERCIAL GAS ASSOCIATION.—The British Commercial Gas Association will hold its tenth annual conference in the Royal Technical College, George-street, Glasgow, on Tuesday and Wednesday, September 27th and 28th, 1921, under the presidency of Mr. D. Milne Watson, M.A., LL.B., President of the National Gas Council and Governor of the Gas Light and Coke Company, London. Members of the conference will be welcomed by the Lord Provost of Glasgow and entertained to luncheon by the Lord Provost, Magistrates and Corporation of the City of Glasgow. Mr. Milne Watson will deliver a presidential address, and the following papers will be presented:—"The Hygiene of Gas Heating," by Mr. John W. McLusky, A.M.I. Mech. E., engineer and general manager, City of Glasgow Gas Department; "The Prevention of Smoke Pollution," by Mr. J. S. Owens, M.D., A.M. Inst. C.E., F.G.S., F.R.S.I., superintendent, Advisory Committee on Atmospheric Pollution; "Gaseous Fuel in the Shipbuilding World," by Mr. George Keillor, engineer and manager, Greenock Corporation Gas Department; "A Thousand and One Uses for Gas," by Mr. Samuel Milne, engineer and manager, Aberdeen Corporation Gas Department; "Production, Distribution, and Uses of Gas Coke," by Mr. E. W. L. Nicol, fuel expert and engineer to the London Coke Committee.

Forthcoming Engagements.

TO-DAY.

WEST BROMWICH ENGINEERING SOCIETY.—Technical School, West Bromwich. "The Production of Iron," by Mr. C. E. Roberts, B.A., B.Sc. 7.30 p.m.

WEDNESDAY, SEPTEMBER 7TH, TO WEDNESDAY, SEPTEMBER 28TH.

THE SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.—Olympia.

WEDNESDAY, THURSDAY AND FRIDAY, SEPTEMBER 21ST, 22ND, AND 23RD.

THE INSTITUTE OF METALS.—Autumn meeting in Birmingham. For programme see page 151.

TUESDAY, SEPTEMBER 27TH.

THE SHIPBUILDING AND ENGINEERING EXHIBITION.—Olympia. Lecture on "Balancing Rotary Bodies." 3 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY GRADUATES.—The Mayoress's Parlour, St. Mary's Hall, Coventry. Business meeting. 7.45 p.m.

WEDNESDAY, SEPTEMBER 28TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM GRADUATES.—Chamber of Commerce, New-street, Birmingham. Business meeting. 7.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Eastern District meeting at Dorking. Inspection of housing scheme, destructor works, outfall works, &c. Paper to be discussed, "Municipal Works at Dorking," by Mr. S. S. Gettings, A.M. Inst. C.E. 11 a.m.

THURSDAY, SEPTEMBER 29TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: LONDON GRADUATES.—28, Victoria-street, S.W. 1. Business meeting. 7.30 p.m.

ASSOCIATION OF RAILWAY COMPANIES' SIGNAL SUPERINTENDENTS AND SIGNAL ENGINEERS.—The Railway Clearing House, London. Sixty-third conference.

WEDNESDAY AND THURSDAY, OCTOBER 5TH AND 6TH.

COMMERCIAL MOTOR USERS' ASSOCIATION.—Fourth Provincial Conference of the National Council at Bristol.

SATURDAY, OCTOBER 8TH.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—Holborn Restaurant, London. Twenty-first annual dinner, 6 p.m.

MONDAY, OCTOBER 10TH.

INSTITUTE OF TRANSPORT.—Victoria Hall, Hotel Cecil, London, W.C. 2. Second Institute Dinner. 7.30 p.m.

TUESDAY AND WEDNESDAY, OCTOBER 11TH AND 12TH.

INSTITUTION OF GAS ENGINEERS.—Central Hall, Westminster. Annual meeting.

CATALOGUES.

HERBERT MORRIS, Limited, Loughborough.—Booklet No. 97, dealing with Morris hand cranes. The different types of crane are illustrated.

BOWDEN WIRE, Limited, Victoria-road, Willesden Junction, N.W. 10.—Illustrated booklet entitled "Why a Bowden Wire Extra Air Inlet?"

THE BRITISH RUBBER TYRE MANUFACTURERS' ASSOCIATION, Limited.—Explanatory pamphlet dealing with the position of the rubber tire industry in Great Britain.

GEAR GRINDING COMPANY, Limited, Handsworth, Birmingham.—Illustrated booklet dealing with "Motor Car Gear-box Production and Design," with special reference to gear tooth grinding.

F. A. WILKINSON AND PARTNERS, Limited, Hatfield, Herts.—Illustrated pamphlet on "Wind Power for the Generation of Electrical Energy by Means of Automatic High-speed Wind Dynamos."

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Limited, Trafford Park, Manchester.—Circular No. 1790/1 dealing with motor equipments for main rolling mill drives, of which many illustrations are given.

THE BRITISH REINFORCED CONCRETE ENGINEERING CO., Limited, 1, Dickinson-street, Manchester.—Copy of the July issue of "Road Reinforcement," a pamphlet issued occasionally in the interests of B.R.C. fabric.

HIGGS BROS., Sand Pits, Birmingham.—The firm's monthly magazine. A new specification and price list of motors has been prepared and may be obtained on application either to Birmingham or 265, Strand, London, W.C. 2.

A. D. DAWNAY AND SONS, Limited, Battersea, S.W. 11.—Handbook dealing with constructional steel work. The tables and data for the design of constructional steel work have been compiled by Messrs. Dawnay's technical staff.

DAVID BRIDGE AND CO., Limited, Castleton, Manchester.—Illustrated pamphlet dealing with Heywood and Bridge's improved patent friction clutches, gearing and hauling installation. The drawings are reproduced to represent blue paper prints.

THE BRITISH ALUMINIUM COMPANY, Limited, 109, Queen Victoria-street, E.C. 4.—A series of little leaflets dealing with "Hints on Working Aluminium," have been received and deal with the following subjects:—Aluminium ingots, sheet, circles, tubes and sections.

WOLSELEY MOTORS, Limited, Adderley Park, Birmingham—Illustrated booklet No. 609, dealing with "Wolseley" gauges, taps and dies. Up to the present these gauges have been manufactured for the firm's own use, but now they are to be offered to engineers in general.

THE ENGINEERS' SUPPLY COMPANY, 81, Bradford-road, Shipley.—Leaflets have been received dealing with the following subjects:—The "Esco" saw bench, tungsten steel hack saw blades, oil cabinets, balata and hair belting, the "Esco" friction hoists, and the "Esco" mortar mill.

CONSETT IRON COMPANY, Limited, Consett, Co. Durham.—Leaflets dealing with silica bricks which the firm is at present in a position to supply, also fire-bricks. Leaflet dealing with steel joists, 4in. by 2in. and 5in. by 4½in., which the firm is proposing to roll almost immediately.

SIMON-CARVES, Limited, 20, Mount-street, Manchester.—Pamphlet dealing with coal-washing, handling and crushing plants. Many illustrations are given of installations which have been erected. Sectional drawings of plant are given and a series of maps has been included, indicating where plants have been erected on the coalfields.